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SCHOOL SCIENCE
AND
MATHEMATICS

VOL. XLII DECEMBER, 1942 WHOLE NO. 371

SELECTION OF MATHEMATICS TEXTS

CECIL B. READ
University of Wichita, Wichita, Kansas

Procedures for selecting texts vary in colleges and universities. In some cases the instructor has the entire decision in his own hands, although this is more likely to be true in upper division courses. Some institutions require that a text once adopted must be retained for a stated period; others require that the stock on hand in the university book store must be exhausted before a change is made. If no exceptions are permitted, it will probably be agree that the two rules mentioned are unwise.

Although one could always mention exceptions, it is in general desirable that where there are several sections of the same course the same text should be used in all sections. Among other reasons one might point out that otherwise an unjustifiable financial burden is placed upon the student who for any reason changes sections; likewise such a student may, because of different arrangement of subject matter, fail to hear important topics discussed in class.

If a text is to be used by more than one teacher, it should meet with the approval of all members of the department who will have to use it, hence the selection of the text becomes the concern of a group, perhaps the whole department, perhaps only a portion of the department. With a very large department, some of the detail may be handled by a committee, but every teacher who will use the text should have opportunity to express his opinion.

Unfortunately, in many cases the decision rests upon one or two factors, which may be extraneous. For example, some one

may have a favorite publisher or friendship with an author; the size of the adoption list may be impressive; some department member may be loud in praise of his particular choice, while a superior books fails to receive consideration.

To avoid this unfortunate situation, various rating scales have been proposed; some are available in printed form. Although they have distinct merits, there are some distinct disadvantages; (1) A scale may be put out by a particular publisher and is hence likely to have a bias in favor of that publisher's books; (2) Many rating scales are made to cover texts in general, rather than in the field of mathematics, and include rating of topics unnecessary or perhaps even undesirable in a mathematics text; (3) The individual department may consider very important certain factors not even mentioned in a rating scale; (4) It is a laborious task to conscientiously rate a book with a scale yet a very brief inspection may make it clear that the text is undesirable.

In an attempt to overcome some of the objections mentioned, yet retain valuable features of the objective scale; a plan is offered as a means of achieving the desired end. In order to give concrete illustrations, some features of the plan will be mentioned as they were applied in the selection of a text book in beginning trigonometry, taught by five instructors at the University of Wichita.

First: The instructors involved, working with the department head or professor in charge of the course, should arrive at a definite decision regarding the general specifications required in a text. In the situation mentioned, it was agreed that: The text need not cover spherical trigonometry; tables were to be bound with the text; there should be included at least an elementary treatment of inverse functions, of trigonometric equations, and of graphs of trigonometric equations; the acute angle should be treated first, then the general angle; and that logarithmic solutions should not demand the use of co-logarithms. While there may be marked disagreement with these specifications, there will probably be universal agreement with the statement that a suitable set of general specifications for any particular course can be drawn up.

Second: With the general specifications in mind, each book under consideration should be examined briefly by at least two instructors. If these agree as to unsuitability, the text is rejected from further consideration. In our concrete illustration,

forty-two trigonometry texts were examined briefly. Each instructor checked about 15 texts and the book was rejected whenever two agreed it was not suitable. The assignment was so made that no two individuals read the same list of books. This reduced the number of texts under consideration to sixteen.

Third: All books on which there is disagreement should be examined briefly by another instructor. In the illustration, this was done whenever the first readers were not in agreement; if two out of three failed to approve, the text was rejected. This reduced the list to ten books.

Fourth: An objective rating scale, designed especially for the particular situation is prepared. The items may be checked as accurately as one desires. Since the preliminary elimination has weeded out the very poor texts, perhaps rating on a three or four point scale will be sufficient. It should be emphasized that the scale should include all items considered pertinent by the department. It is perfectly possible to allow space for rating books as they do or do not conform to some particular idiosyncracy, but a scale may avoid giving too much weight to such an item. The remaining books are measured by this objective scale. In our particular case each instructor rated two books, reporting his rating on the various items at a group meeting, where his judgment could be checked if desired. This immediately reduced the choice to three books, of which two seemed especially fitted to our needs. Each instructor then individually rated these three books, if he had not already done so, resulting in unanimous agreement on the text selected.

At first glance the procedure outlined may seem unnecessarily elaborate, however, the selection was made within a month's time and we now feel the effort well worth while. With a smaller group the second and third steps might well be combined, with a larger faculty one might omit the third step by having three people rate every book as in step two.

It is very definitely the opinion of the author that it is important to develop a rating scale for the situation in hand, rather than adopt criteria made for other situations. However, because of questions which have arisen when discussing the procedure with friends, some criteria which might be used are mentioned:

What is the reputation of the publisher?
What about the education, training, and experience of the author (s)?
What is the date of publication? (Recent publication does not necessarily imply excellence.)
Is the index comprehensive enough?

Are there enough tables for your course? To illustrate, some teachers wish a table of secants which is not found in many texts.

Is the arrangement of the tables satisfactory?

Are there enough problems to provide different assignments?

Are the problems graded as to difficulty?

What answers are available to the student? to the teacher?

Is there sufficient detail in the explanations?

Are the illustrative examples clear?

Are review lessons provided at appropriate places?

Is the organization of the subject matter satisfactory?

If material is included which is not in the course content, can it be omitted without destroying continuity?

Are obsolete topics omitted?

Are there topics which are not handled satisfactorily? To illustrate, some teachers object to the scale on graphs of trigonometric functions as it appears in many texts; some feel the treatment of quadrantal angles is often not good.

Is the binding and quality of paper satisfactory?

Is the book in a clear and easy to read form, even under artificial light?

Is the price satisfactory?

Is the accuracy with which results are expressed consistent with the data given?

Has the book been tested in the classroom? It should be pointed out that a long list of adoptions, particularly if very recent ones, does not necessarily mean a successful text.

In conclusion, it may be mentioned that some instructors refuse, and perhaps rightly so, to consider any text that they have not had on their desk for at least a semester, comparing with the text now in use. In fact, unless conditions such as the knowledge of a complete set of solved problems available in some fraternity house files makes a change imperative, one should always consider the present text in the rating process. One might be surprised to find it superior to anything else available.

LANDING GEAR BUFFERS USED AS RECOIL-ABSORBERS

Fighting planes normally have to absorb hard bumps of two kinds: the shock of landing and the stiff backward push of guns in recoil. Landing-gear buffers and recoil-absorbing cylinders are essentially the same kind of mechanisms: arrangements of pistons working against the resistance of either oil or compressed air, frequently with springs to aid their action. It has occurred to Carlos C. Goetz, a New York inventor, to utilize the landing gear buffers of airplanes also for absorbing gun recoil, thereby saving the weight of separate recoil cylinders. U. S. patent 2,299,227 has just been issued to him, covering this principle.

Pivoted levers, shaped according to relative positions of guns and buffer cylinders, transmit the shock of recoil from guns to buffers. Since the light cannon or heavy machine guns of a plane are never used when the landing gear is down, the apparatus is so constructed that it can be operated as a recoil mechanism only when the wheels are in fully retracted position.

HIGH SCHOOL CHEMISTRY STUDENTS CONCEPTS OF ATOMIC AND MOLECULAR STRUCTURE

M. J. W. PHILLIPS
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[Science is no longer a subject hidden in mystery and studied only by hermits in dark basements or garrets. Many of our most popular magazines give pages to displays and articles on scientific subjects including atomic structure. In order to find out what ordinary high school students know and think about the subjects they study Mr. Phillips investigated and here briefly presents the results.—Ed.]

High school chemistry textbooks have one or more chapters on atomic and molecular structure. These discussions are taken up under Valence and the Periodic Law. Newspaper items and some pictorial magazines discuss atomic structure in connection with atom "smashing." What kind of concept does the high school pupil obtain from reading this material and looking at the diagrams with accompanying explanation?

So atoms can be smashed? What are the pieces? What is the ultimate building block the Creator used to create the ninety-two elements, anyhow? These and a multitude of other questions arise in the mind of the beginner in chemistry.

The writer asked one of the chemistry classes to read everything in the textbook, in newspapers and pictorial magazines and try to visualize the atom and then the molecule from the materials presented. There was no class discussion and no suggestions were given by the teacher. They were asked to choose any atom and construct a model of the atom selected. They might select any material to represent electrons and protons, and the forces holding these in place. We set aside a day to bring in these atomic models for display and discussion. The day was designated as "Atom Day."

A few of the atomic models are shown in Figure 1. Numbers 1, 3, and 6 are models of the carbon atom. Number 1 was made of carefully hand carved spheres of balsa wood to illustrate the electrons and an equal number of spheres in the center to represent the nucleus. Number 3 in the illustration was made entirely of corks and wire. Number 6 in the illustration has a red rubber ball for the nucleus, wire to represent the electron orbits, ping-pong balls for the electrons in these orbits. Number 4 is a model of an oxygen atom; the small rubber ball represents the nucleus and glass beads as electrons. Number 5 is the hydrogen atom

with a large rubber ball for the proton and a small cork sphere such as is used as a float in fishing tackle for the electron.

Number 2 in the illustration shows one student's concept of an aluminum atom. The thirteen electrons are made of split lead shot such as is used for sinkers in fishing tackle and were fastened on circular wire to represent three orbits, with a ball of tightly wound cord for the nucleus in the center. All this is mounted upon a base to support it in order that more than one plane might be shown.

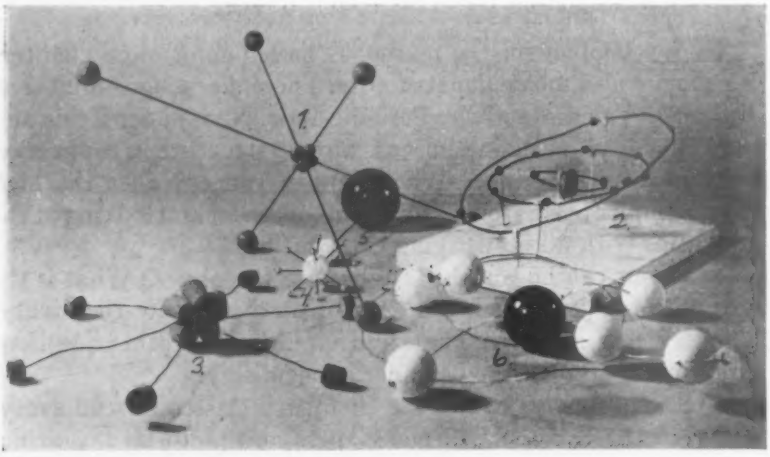


FIG. 1. Atomic Models made by high school chemistry students. 1, 3 & 6 are Carbon Atoms. 2. Aluminum Atom. 4. Oxygen Atom. 5. Hydrogen Atom.

Over thirty-five atomic models were made, but only six representative ones are shown here. One boy, not a good student, stated that he was going to model the uranium atom, because it had ninety-two electrons. A member of the class asked him how he was going to get such a large atom to school. He brought his model of the uranium atom, a large ball for the nucleus mounted in the center of a large card board, on which he glued ninety-two glass beads to represent electrons. When it was on display, some of the glass beads loosened and dropped to the floor. He was criticized by a member of the class to which he replied, "Uranium atoms are supposed to act that way; they lose electrons because they are radioactive." This boy had associated radioactivity with the atom in this case—something he had obtained from his reading.

From very early times philosophers have speculated on the structure of matter; and it is recorded that as early as the twelfth century B. C. Indian men of learning held the theory that matter is not infinitely subdivisible, but is atomic in structure. In 400 B. C. atoms were indivisible for Leucippus because they were too minute to be divided and for Democritus because they were too hard to be broken. Then we find a series of concepts of atomic structure that existed until the discovery of X-Rays and radioactivity which gave rise to the quanta of Planck and the atom concept of Niels Bohr. Quanta, those

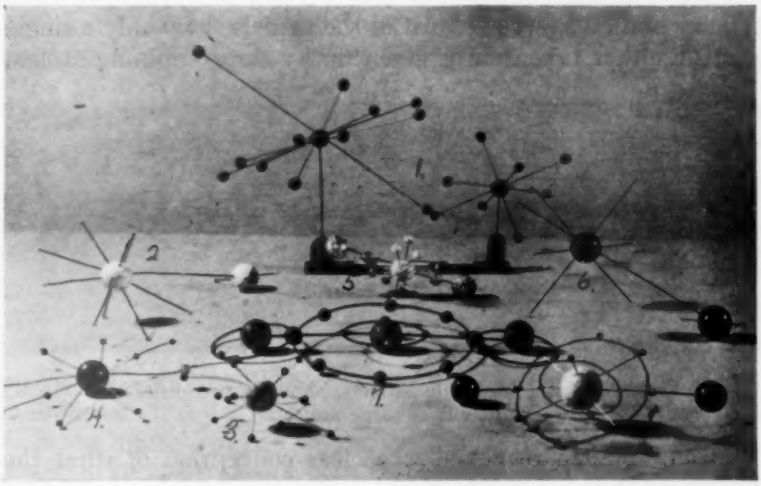


FIG. 2. Molecular Models made by high school chemistry students. 1. Magnesium Oxide. 2 & 6. Lithium Oxide. 3, 4, 5, 7 & 8. Water Molecules.

"gobs" of energy that rise and fall, appear or disappear, when an electron shifts in its orbit, if it does.

The electrical nature of the atom is fascinating but difficult. In consulting old textbooks* of chemistry, one finds no mention made of the structure of the atom except in connection with valence in the formation of compounds, " . . . and no such molecule can exist unless its parts are bound together by these atomic clamps." At least atoms had clamps of some sort to hold each other together to form compounds. The same author revised this text in 1891, but at that date no further change in the concept of the atom seems to have taken place; as a matter of fact, the only addition is the element fluorine, which was isolated by

* Cooke, Josiah P., Jr., *The New Chemistry*, Page 250, D. Appleton and Company, New York, 1873.

Moissan in 1886 and a few changes in some of the then known rare earths.

About 1900 the atom clamps disappeared and electrons began to play the part; some atoms "grab" electrons, while others seem to "let go" of electrons when compounds are formed.

Following the atom, the next problem for the pupil was to build a model of a molecule of some compound, which was not as easy. Figure 2 shows eight models of molecules: (1) Magnesium Oxide, (2 & 6) Lithium Oxide, and (3, 4, 5, 7 & 8) Water Molecules. Here again various materials were used—from Christmas tree ornaments, glass beads to spheres made from putty, modeling clay and balsa wood. Most of the models show only a single electron either taken on or given up by the combining atoms.

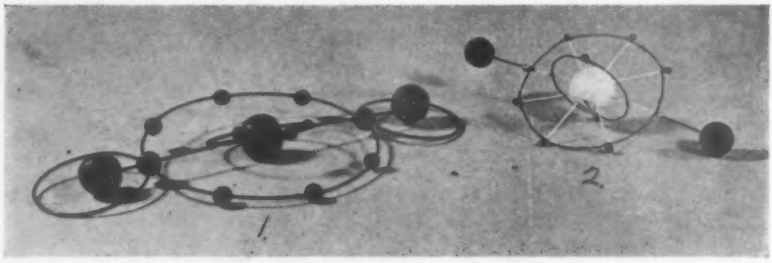


FIG. 3. Water Molecule Models. Showing two different concepts of same molecule.

The pupils failed to get a very clear conception of what the writers tried to convey. Note the two molecules of water shown in Figure 3. No. 1 is a molecular model in a single plane, orbits and all, while No. 2 shows orbits in three dimensions. Some authors speak of orbits, others speak of inner and outer shells. It is little wonder that the high school pupil and the teacher become confused on this subject.

With the recent advances that are being made in this field of science—the electron microscope, the atom smasher and the discussion of these that follows in the press and on the screen and radio—it is necessary that those educated to appreciate at least a part of it, should be exposed to theoretical material of this kind.

If chemistry instructors are looking for an activity that will arouse more than the usual amount of pupil interest, I would suggest they try this one. After all, high school pupils may not be so far amiss; at least it sets the mind to work, and that is something to be desired in science education.

"RAISING THE MASSES" IS A PROBLEM IN PHYSICS

THOMAS D. COPE
University of Pennsylvania, Philadelphia, Pennsylvania

Mr. J. T. Peters of Philadelphia, Pennsylvania, has just handed me a copy of a paper entitled "The Physics Teacher Faces his Problems," which he published in SCHOOL SCIENCE AND MATHEMATICS for June, 1941. On the first page of this article Mr. Peters refers to an unpublished paper that I once read at Chapel Hill, North Carolina, on February 20, 1937. He says that I commended parts of a book published, not at my institution as Mr. Peters states, but at the University of North Carolina, "but express surprise at some of the statements made."

Neither consciously nor otherwise did I express "surprise." What I did express I am willing to let your readers judge. My paper was entitled—"Some Things that College Physics Expects of Pre-College Education." I quote from it.

"When Stradling was teaching physics in Northeast High School thirty years ago, he enjoyed a gratifying number of degrees of freedom. Neither his classes nor the school were overcrowded. His pupils *came* to school voluntarily. Neither law nor propaganda *sent* them. Supervision of his work was of a mild and inoffensive kind. He had leisure for scientific study, and could dedicate himself to his promising pupils. At the same period, Dr. Paul R. Heyl, now of the National Bureau of Standards, was teaching physics in Central High School, Philadelphia, and was studying the properties of current bearing matter and was measuring the velocity of ultra violet light from the star Algol.

"The successors of Stradling and Heyl today lead a highly constrained existence with little freedom for scientific study or for their more promising pupils. They are constrained by two agencies, educational bureaucracy, and the horde of less intelligent pupils which today overcrowds the public secondary schools. The growth of these two constraining bodies is a phenomenon of the last thirty years. Each has accelerated the growth of the other. With them has grown up a philosophy upon which we shall now remark.

"During 1936 there was published from this University (North Carolina) an excellent book entitled 'The High School Science Teacher and his Work.' I have read it entire. I commend its chapter on 'Safeguarded Thinking' and its chapters on 'Labo-

ratory Work' as little masterpieces. But on page 30 I read—'The task of the secondary school is not that of developing leaders; it is one of lifting the masses.'—'Being tax-supported it exists for "all the children of all the people," not for the mental aristocracy.'

"There is the philosophy in a nut-shell—'not for the leaders but for the uplift of the masses.'

"Let us analyze this claim. Where is the line to be drawn between the 'mental aristocracy' and the 'masses'? Our book has no suggestion. I shall offer one. Is our high school boy able to master Millikan and Gale's *Physics* and is he willing to make the necessary effort? If yes, he is my aristocrat, if not, he belongs to my masses.

"Granted that the boy belongs to the masses—the alleged chief concern of the secondary school. Now what of his future? I will tell you with assurance a number of things that he will never do if he cannot or will not master Millikan and Gale. He will never practice medicine. He is too stupid or too lazy to master the underlying sciences. He will never graduate from a high grade dental school. He lacks the physics necessary. Engineering in all its branches is closed to him, and, needless to say, he will never be a physicist, and the chances of his ever teaching physics are slim.

"But suppose that he can master Millikan and Gale and does so. As high school boys go, he is a 'mental aristocrat.' He may some day practice medicine, or dentistry, or engineering, and may rise to leadership in his profession.

"But developing leaders is not the task of the secondary schools—it is that of lifting the masses.

"Just how are the masses lifted, and who does the work of lifting? Mussolini, Stalin, Hitler, and others nearer home claim to be lifting the masses. Millions of votes would support their claims. Time alone will decide whether the masses have been lifted or have been degraded by them. Let us resort to less debatable instances.

"Perhaps nearly all will agree that among modern men no one has done more to lift the masses than Louis Pasteur. And how was it done?

"First of all, from the obscure schoolmaster in the remote province 'who talked to the boy of his future and opened to him the prospect of the great Ecole Normale' to the famous J. J. Biot who was overjoyed to meet a young man who could teach

him something new about polarized light, the educational system of France worked as a unit to recognize, encourage, and develop the youth of great promise.

"But why continue? Lifting the masses is the same story today as it was in the beginning and ever shall be. Great intellectual and moral leaders like Pasteur discover new knowledge, establish new principles, develop new techniques. Intelligent men grasp what has occurred and change their lives accordingly, and gradually the physicians, the dentists, the engineers, and the teachers, and other propagandists convey the new knowledge and the new practices to the masses of mankind.

"But the task of the secondary school is not that of developing leaders; it is one of lifting the masses.

"Without the original great leaders, the Pasteurs, uplifts will never start. Without intelligent leaders to grasp what has occurred and to pass it on the uplift cannot spread. The sentence which I have quoted and requoted states a worthy objective—to lift the masses—and also the most effective way of defeating the objective that man could contrive—give no thought to the development of leaders.

"The greatest uplifter of all time devoted most of his career to the training of twelve carefully chosen leaders.

"College physics expects pre-college education to revise that sentence to read 'The public school exists for "all the children of all the people," for the ambitious and the intelligent as well as for the lazy and the stupid. Its task is that of lifting the masses by all reasonable means, chief among which is doing its part in the education of those who give promise of leadership of a right kind.'

"The physicist knows from bitter experience that antithetical concepts, such as 'particle' or 'wave,' if pursued to extremes lead into difficulties. So do such concepts as 'mental aristocrats' or 'masses.' Our book on the High School Science Teacher puts the case well when it says 'the pendulum in education is at times likely to swing to extremes.'

"Who are better qualified to deal with the pendulum than the heirs of Galileo and Huyghens—the physicists. It behooves us physicists in our A.A.P.T., our local chapters, our clubs, wherever and whenever we meet, to apply well timed, well measured and rightly directed impulses to this pendulum of education to accelerate it out of the extreme phase of mass and

moron worship into which it has recently swung, towards a better balanced position.

"The pupils of intelligence and ambition are our only possible source of college students, of professional men and women, of trustworthy leaders in future social uplifts. To them society owes a pre-college education that prepares for college. Clear-headed schoolmen in Philadelphia tell me that three distinct types of high school are urgently needed—trades schools, business preparatory schools, and college preparatory schools. To each pupil society owes an education adapted to his grade of intelligence and to his willingness to use it.

"The closing section of this paper is dedicated whole-heartedly to a sentence from 'The High School Science Teacher' which reads—

" 'It never has been, and probably never will be, possible to substitute any kind of robot, even of the human variety, for the intelligent and well prepared teacher'."

Six months after Mr. Peters published in June 1941, those whom he sought to protect from the "Great God Rigor" found themselves face to face with the god and all his cohorts on land, on the sea, and in the air. And to the problems of the physics teacher has been added the urgent one of teaching enough physics to tens of thousands of our younger people to qualify our armed forces to understand and to use the implements of modern warfare.

And our great democracy in its desperate effort to survive has set up elaborate machinery for discovering "good officer material" and for developing this material into "leaders" competent to render the services of the "masses" of the rank and file effective. And all the while, no doubt, some "educators" are saying to themselves that the task is not one of developing leaders but of saving the masses from slavery.

World War II will contribute nothing to human intelligence, but it will add its quota to human experience. And perhaps some "educators" as they grow older will reflect upon the Fool's Paradise in which they lived, moved and had their being from the close of World War I until one year ago. The "war to end all wars" had been won. "The world had been made safe for democracy." The age of hard work was behind us and the age of plenty just ahead. Why study the hard subjects, like physics, when there are so many easy ones to select from?

A worthy successor to G. F. Stradling has put it: "The es-

sence of their philosophy is the removal of effort and hard work from the process of acquiring an education." But old Ben Franklin, who was both a physicist and a Philadelphian, once remarked "Experience keeps a dear school and 'some' will learn in no other."

NEW LIFE AMID BURSTING SHELLS

SISTER ROSEMARY MCMANUS, R.S.M.
Mercy High School, Milwaukee, Wisconsin

For unlimited interest, information and real fun, try incubating a few dozen chicken eggs. Our biology class did just that. Soon we had an energetic, healthy brood of fluffy chicks.

From the first day questions came like a heavy snow storm, thick and fast.

"Do you mean to say those eggs are just like the ones we had for breakfast, and that chickens will come out of them?"

"Does the shell stretch as the chick grows?"

"When does the egg become alive?"

Humidity and thermostatic control of temperature did not have to be taught under pressure but were looked up, compared with the furnace control at home, and then thoroughly discussed. Science students, non-science students, parents and friends added their store of knowledge to the general fund. One of the girls was heard to remark, "I used to think our furnace was almost human—it works so well. Now I know that it is regulated by a simple device. But still it is marvelous."

Day by day we watched the progress of the embryo chicks by opening an egg and observing it under a dissecting microscope. "Why, it's just like the pictures!" came the surprised exclamation. Even the meticulous didn't think that the eggs were "messy," and they joined the others in their search for magazine articles and pictures. "Wonderful!" was the reaction to reports that until now held only passing interest for the majority. Students who had lived on the farm admitted that they learned a great deal more about the chicks than they did when the mother hen did all the work. By the twelfth day the students were thoroughly convinced that chicks do hatch from eggs, that life is present from the beginning and that the shell doesn't stretch.

One day the temperature jumped to one hundred and six degrees, and great was the concern of everybody. What would

happen? Would the chicks die? Would it hurt them if we lowered it to one hundred degrees in order to give them the same amount of heat? So much a part of their life did the chicks become that they worried about them if an electric storm, which might shut off the current, came up during the night.

As soon as "peep-peep" was heard, we transferred some of the eggs to a large glass case where the proper temperature was maintained. All day long, groups of students watched, fascinated. The place of someone who had to leave was quickly filled, and at six o'clock that evening there were quite a few girls who had to be reminded that it was time to go home for dinner. The following morning, and all the next day, the incubator was the center of attraction for practically the whole student body, faculty members, parents and even a bridal party. The groom gave us some good advice on how to care for the balls of fluff.

While the ever-present budget must be considered in many undertakings, there was no such worry in this case. In fact it was possible not only to keep out of the red but to go into the black. The chicks more than paid for the eggs and electricity. The camera club also came in for a little remuneration for lending us the printing box to candle the eggs. We took snapshots and printed them in our own darkroom. Many of the students ordered prints for their memory books.

The time came when our feathered pets had to leave school, but that was not the end of the story. Since it would not be wise to keep only one chick to raise, each student who took one home bought others to keep it company. Consequently, there were a few "back yard chicken farms" that otherwise would not have existed. Since the defense program calls for an increase in poultry raising for meat and eggs, the project assumes a practical character in addition to its educational value.

PHOTOCELL-OPERATED BOMB SIGHT

An automatically operated bomb sight, in which a photocell causes release of the bomb when the cross hairs come on the target, is the subject of patent 2,299,313, issued to Franklin W. Durgin of Washington, D. C. The sighting tube carries a small lamp, which projects a light against a mirror carried by the plane's speed-indicating instrument. Thence the beam is projected against a second mirror on the altimeter, and from there to the photocell on the release mechanism. All sighting adjustments are thus made automatic. Until the sight comes upon the target the light beam does not fall on the photocell. As soon as it does, the bomb is released without further action by the bombardier.

THE JUNIOR ACADEMY IN THE EMERGENCY

LOUIS A. ASTELL

Supervisor, Science Aids Service, Division of University Extension, University of Illinois, Urbana, Illinois

"The greatest service science could render would be to create within every human being an unselfish scientific attitude, a burning enthusiasm for an active participation in achieving the social economic goal of a democracy of maximum equal opportunity for all."—M. E. Hurst on "Science Serving a Democracy."

In time perilous for education and democracy alike, we find that science instruction represents but six per cent of the total school program. Science teachers, as well as administrators, have long been aware of this shallow recognition for science. These educators know that educationally there is no justification for designating this era as the age of science.

Neither science teachers nor administrators can increase, overnight, the amount of science instruction as such. Both groups, however, can work together with the public for constructive changes in the curricular offerings. In the meantime, these educators may bring about an immediate change in the extra-class program. The organization of one or more science clubs represents a practical and an immediate answer to the challenge.

In the development of these science clubs, the deeper needs of the individual and of our democracy should be met. Home rooms, organized around segments of the school roster, do not meet the psychological and sociological needs common to youth any more than women's clubs based on city blocks or pages from your telephone directory can be made to serve the personal needs of the mothers of these same youth. The natural loyalties of young people for their friends with common interests may be used to build the larger loyalties which serve the State and nation. In the struggles of democracy yet to come we should not overlook any means of combating subversive organizations which constantly menace our security. In a democracy it is vital to be able to depend on overpowering loyalties openly and freely arrived at to conquer the fanaticism produced by such ideologies as those developed by the Nazis. The Junior Academy movement then, has largely been the result of an awakened social consciousness on the part of science teachers and administrators for the permanent needs of our demorcacy.

This emergency, it should be said, is not the first one which the Junior Academy has met. In fact, the Junior Academy may

be thought of as one of the products of the last great national emergency and the influence of that cataclysm on the thinking of scientists in our State with reference to educational needs. Specifically, it was at the annual meeting of the Academy in May, 1919, when Doctor J. L. Pricer concluded his annual Secretary's Report with this thought:

"Education in science is so vital to the general welfare of every phase of science that it seems to me that every member of the Academy should have some interest in the problems of science education in the secondary schools."

It was through this vision of Doctor Pricer that a committee of three members laid the foundation of our pioneer organization, and it is with great pride that the Junior Academy has retained in its organization through these many years one of the four original science clubs. That club is the Danville Science Club which at this time is under the sponsorship of Mr. C. O. Johnson.

The Junior Academy idea has met with a most favorable response in other states. Today, there are no less than 23 states with Junior Academies and there are other Academies in the process of organization. The Junior Academy movement has been a reality for many years. The results of the movement have been so phenomenal that Doctor Howard E. Enders, Dean of Science at Purdue University, who has followed closely the development of the organization in state after state, found occasion several years ago to say that "The Junior Academy Movement clearly is the outstanding achievement which has grown out of the formation of the Academy Conference." So the Junior Academy, born in the wake of an earlier emergency, has assumed significant proportions when we consider the special group of students with which it is primarily concerned.

Some proof of the value of the Junior Academy in Illinois is found in the fact that it has served those students interested in science for a twenty-two year period, years which included the longest and most serious depression our country has ever known. It has continued to prosper when organization after organization founded by magazine and book companies has failed. The Junior Academies succeeded because the profit motive was not a part of the plan and because they had nothing to offer but service. For us, today, the point is that the Illinois Junior Academy is alive and functioning with little benefit of superstructure.

In the academic year of 1939–40, a working relationship was developed between the Division of University Extension at the University of Illinois and a group of cooperating Junior Academies of Science. The Academies involved at that time included Illinois, Iowa, Minnesota, and Indiana. Such relationships as that with the Principals' Association and the Division of University Extension mean that the Illinois Junior Academy has moved to a place definitely related to the administrative and supervisory agencies of the secondary school system.

Because the Junior Academies have been concerned with the identification and fostering of scientific interests at the secondary school level, and because most State or Senior Academies, as such, were concerned with the needs and interests of graduate students, teachers, and professional scientists, the undergraduate students have not always received the encouragement which is due them. Within the past few years, however, certain State Academies and the American Association for the Advancement of Science have been interested in the founding of undergraduate or collegiate sections of the State Academies.

Such a section was organized in Texas during the fall of 1937 and in Kansas during the academic year of 1939–40. The success of these two organizations has been so marked that a similar organization is being developed in Illinois. The inaugural meeting for the undergraduates from the various colleges and universities of the State is to be held at the time of the annual Academy meeting at Urbana in May.

For those interested in the implications related to educational advances at the secondary school level, Doctor R. F. Paton of the Physics Department at the University of Illinois points out that the undergraduate members of the Collegiate Section, in many instances, will logically become the high school science teachers of the State. "The firmer grasp of research principles as applied to science," he thinks, "will undoubtedly play an important part in science teaching."

Essentially, the Collegiate Section does not represent "another organization." Rather, like the Junior Academy, it represents a unification and reinforcement of the efforts that are being expended in the interest of human needs. These Collegiate Sections will continue to spread just as the Junior Academies have done because they represent something very vital in the development of scientists, of whom we see now as never before a real shortage. These Collegiate Sections will continue to serve,

because scientists themselves can no longer forget the importance of translating the fruits of science into human action.

On the positive side, it should also be noted that American scientists have long recognized that in the depths of emergencies and out of them, it is most important to identify, encourage, and direct youthful scientists. In this crisis then, scientific endeavor is being actively conserved, directed, and coordinated from the early juvenile level to the adult level of activities, through the efforts of your State Academy and others like it.

Scientific endeavor, as you know, is commonly concerned with genuine human needs and represents one of the sharp contrasts between the democratic way of life and that to be found in the totalitarian states where scientific endeavor is deliberately perverted into other channels. Thus, Frederic Sondern describes the work of "The Thousand Scientists Behind Hitler."* Those scientists represent the personnel of the Geopolitical Institute of Munich which has been operating since 1933. This Institute, operating under Major General Professor Doctor Karl Haushofer, is responsible for the Nazi formula of destruction with its split-second timing; the formula which functioned so perfectly in the pillage of country after country during the opening phases of the present war, and which is openly devoted to the cause of world domination.

Free countries are now forced to contribute their last ounces of immediately available energy to meet the calculating adversaries who move under the heinous direction of Haushofer's Geopolitical Institute. In such an extremity, these same free countries are gaining much valuable momentum because they are beginning to utilize the scientific potential that is available. Our country, for example, has now established a National Defense Research Committee. Through such organizations, "It may well be that men of science, not kings or warriors, or even statesmen, are to be the heroes of the future." In the meantime, and for the emergencies to come, the Junior Academies are rendering a service of incalculable value.

* Sondern, Frederic—"Hitler's Scientists," *Current History and Forum*, 53: 10-12, 47, June, 1941.

"Male college students can no longer consider themselves as candidates for degrees. They are now candidates for the nation's armed forces."—*Arthur Van Duren, Academic Counselor, University of Michigan, who warned students that "stiff" math and physics courses await all of them in the classrooms.*

THE COMPUTOGRAM

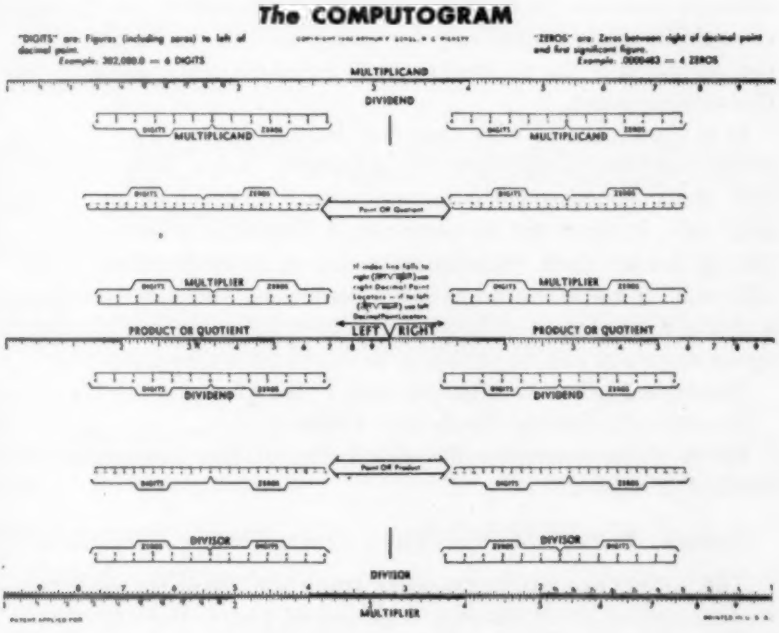
ARTHUR F. ECKEL
161 W. Harrison St., Chicago, Illinois

The Computogram is a simple calculator consisting of logarithmic scales combined with decimal point locators.

Its conception resulted from a long-felt need for an instrument intermediate between old computational processes and the slide rule.

The Computogram enables even a grade school student to make calculations and to place the decimal point with unerring accuracy. The scales are of equal length and are graduated in the same manner as the scales on the slide rule. This is done to enable the beginner to make a logical transition from the Computogram to the slide rule.

The Computogram, which is a generalized Nomogram, is in one respect a "fixed" slide rule.



The scales are stationary and values comprising dividends, divisors, quotients, multiplicands, multipliers, and products are read at the points of intersection of a straight line (the index line)

on three equidistant parallel lines. A sequence of operations can be performed on the instrument by the simple expedient of evaluating factors two at a time and combining until the final result is obtained.

Theory of the Computogram

You will recall that the simple three line Nomogram comprises a set of three parallel lines with logarithmic scales. If these three lines are also equidistant from one another, and are graduated with identical outer scales, enclosing a third scale graduated with two compressed logarithmic scales occupying the same overall length as the two outer scales, the middle line will read quotients or products depending whether one or the other outside scale is in the same direction or inverted with respect to the other. It is observed that products or quotients in this generalized Nomogram need not necessarily be read off the middle line, as the lines can be used indiscriminately if one will take care to locate values on the top or bottom of the middle scale to avoid off-scale answers. It is more convenient, however, to employ the middle scale exclusively for products and quotients, since the operation of the decimal point locators depends primarily on this arrangement.

It is significant to note that the decimal point locators are a novel addition to this form of calculator. Aside from the fact that the Computogram is in one sense a stepping stone to the slide rule, it must not be overlooked, that it is a serious computing device itself without reference or subordination to the slide rule. If manipulated with ordinary care, and if one employs a straight line (termed 'index line') in reading the scales, three figure accuracy can be obtained as in the following examples:

Example 1: *How to Multiply and Point off.*

Example 2: *How to Divide and Point off.*

From these examples the simplicity of the Computogram method is evident.

Decimal Point Locators Give Confidence to Students

The author has had occasion to teach the use of the slide rule to engineering students over a period of years. His experience has taught him that the average student, though enthusiastic over the use of the slide rule at first, quickly becomes distrustful of his slide rule results, and very shortly develops a tendency to abandon its use entirely and resort to arithmetical processes.

Even the student with a knowledge of the laws of exponents and logarithms is confused for a considerable period in knowing where to "pick off the answer."

He is confused as to which way to move the slider, and where to spot the answer if it runs off the scale. This confusion is further increased when he discovers that he must set the demimal point by inspection.

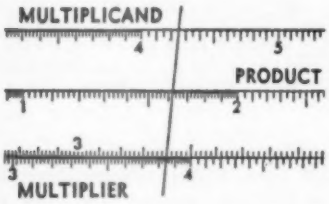
The slide rule, which he had just looked upon as the answer to his calculation troubles, now becomes a "guessing stick."

A New Tool for Better Pedagogy

Today, we teachers appreciate and accept the obligation to fit the student for a place in industry, and therefore we must simultaneously appreciate the necessity of equipping the student with the faster and modern calculating tools. It is taken for

How to Multiply and Point Off

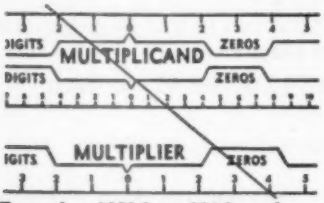
Example: $42.5 \times .0000385 = ?$ "Spot 425 on Multiplicand scale and 385 on Multiplier (lower bottom) scale with a ruler, and you will read 163 on RIGHT section of Product scale.



$42.5 \times .0000385 = 163$

Since the answer falls on the RIGHT half of the Product Scale, the RIGHT Decimal Point Locator will be used.

You have 2 Digits in the Multiplicand and 4 Zeros in the Multiplier; spot 2 Digits on the Multiplicand Locator and 4 Zeros on the Multiplier Locator, and read 2 Zeros on center line as shown below:



Example: $1650.0 \times 274.0 = ?$

These 2 Zeros go to the right of the decimal point, giving the answer as follows:

$42.5 \times .0000385 = .00163$

Index line between Multiplicand 165 and Multiplier 274 shows Product 452. Multiplicand has 4 Digits, Multiplier 3 Digits. Index line on LEFT Decimal Point Locator between 4 Multiplicand Digits and 3 Multiplier Digits shows 6 Digits in answer:

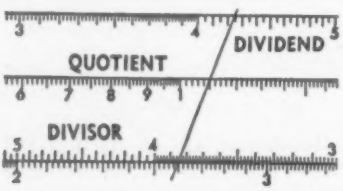
$1650.0 \times 274.0 = 452{,}000.0$

granted that a boy or girl must approach the subject of computations from its elementary side. He must understand the basic manipulations of simple multiplication, division, square and perhaps cube root. He must understand, however, that these elementary processes are not final in themselves, but that advanced number manipulations or computational methods are to supplant the elementary processes. The use of logarithms, the use of tables, abridged multiplication and division, the slide rule, calculating machines and lastly, the Computogram, all find a fitting place in special calculations.

The author seeks comment concerning the Computogram as a transitional or preparatory device, or as a calculator new and apart from old devices combining decimal point locator features.

How to Divide and Point Off

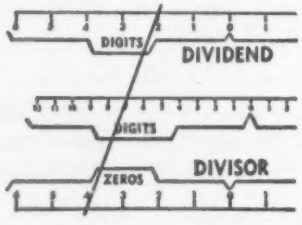
Example: $42.5 \div .0000385 = ?$ "Spot" 425 on the Dividend Scale and 385 on the Divisor (upper bottom) scale, and you will read 110 on the RIGHT section of the Quotient scale.



$42.5 \div .0000385 = 110$

Since the answer falls on the RIGHT half of the Quotient scale, the RIGHT Decimal Point Locator will be used.

You have 2 Digits in the Dividend and 4 Zeros in the Divisor. Spot 2 Digits in Dividend Locator and 4 Zeros in Divisor Locator, and read 7 Digits on center line as shown below:



The answer consists of 7 Digits, so add 4 Zeros to 110 and place decimal point as follows:

$42.5 \div .0000385 = 1{,}100{,}000.0$

Example: $192.0 \div .000342 = ?$ Index line between Dividend 192 and Divisor 342 shows Quotient 561. Dividend has 3 Digits and Divisor 3 Zeros. Index line on LEFT Decimal Point Locator between 3 Dividend Digits and 3 Divisor Zeros shows 6 Digits in answer, thus:

$$192.0 \div .000342 = 561{,}000.0$$

Computograms are manufactured by E-P Calculators, 161 West Harrison Street, Chicago, Illinois.

THE EXHIBIT AS A SUPPLEMENTARY METHOD

V—PHYSICAL PROPERTIES OF MINERALS

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With the nation at war, the natural resources of our country, particularly its minerals, have taken on added interest. Perhaps, then, this would be an opportune time to encourage student interest in the strangely languishing, or altogether neglected, earth sciences. Different methods of creating interest in minerals will suggest themselves to teachers. A method which never seems to fail is a carefully planned and colorful exhibit. One must, however, bear in mind that displaying a few dozen minerals on a table or in a museum case will engage only passing interest. To make the display effective and of lasting consequence, the exhibitor should use every wile at his command. For instance,

(1) The specimens should be very carefully selected so that they are good samples of the minerals represented by reason of (a) purity and (b) crystalline form;

(2) Care should be taken to include as many local minerals as possible;

(3) Labels should enrich the student's knowledge without becoming boring—thus they may give name, synonym, name of the particular variety shown in exhibit, locality where mined, hardness, streak, specific gravity, and any brief allusion to mythology, industry, or history deemed of interest;

(4) Whenever possible, polished gem varieties should be exhibited along with a non-gem specimen of a mineral. This adds color and heightens interest. Local dealers are surprisingly willing to co-operate with interested teachers by making loans of such materials as polished amethysts, agates, crystal, garnets, quartz varieties, synthetic rubies and sapphires, topazes, zircons, etc.;

(5) Part of the exhibit should be given over to a representation of some of the properties and methods by which minerals are identified. In this connection we may list (a) hardness, (b) cleavage, (c) fracture, (d) specific gravity, (e) transparency, (f) color, (g) luster, (h) electrical and magnetic properties, and (i) crystalline form.

An exhibit which includes such a treatment of minerals throws an entirely different light upon their identification for most people, young or old, and presents the mineralogist as a scientist, resourceful and cunning, not as a lucky guesser.

In this part of the exhibit, any interesting or unusual property of any specimen should be exploited to the fullest. For example, the lesson of hardness can be driven home by exhibiting a set of the ten common hardness minerals, generally known as a "scale of hardness." In such a set the diamond is so small as to be visible only under a magnifying glass.[1] The property of hardness somehow becomes romantic by virtue of the use of diamond as its ultimate.

In illustrating cleavage, words avail one very little, in comparison with the impression made by a piece of halite which has been split neatly into two pieces, and exhibited by placing the two newly created surfaces near enough to each other to indicate that a split has taken place. (See Plate II under "cleavage.") Mica, a familiar friend to many young people, is also a good choice to illustrate cleavage.

Interesting examples of fracture are obsidian (conchoidal), flint (sub-conchoidal) and quartz (uneven).

Specific gravity as a method of identification comes to life when illustrated. This is done by suspending a mineral from the beam of a triple beam balance and immersing it in water. The specific gravity is calculated from the formula $A/(A-B)$. A is the weight of the mineral in air, and B is the weight of the mineral in water.

Transparency becomes a striking property when exemplified by a specimen of doubly-refracting calcite placed upon the center of a long line drawn on a card bearing the words: "A single line becomes double when seen through this mineral."

A forceful way of showing color and streak is to draw a piece of black hematite across a piece of unglazed porcelain and then to place the hematite at the end of the streak, with a note: "A black mineral may leave a brown or red streak."

Good examples of luster are: quartz, which is vitreous; amber, which is resinous, and satin-spar, which is silky.

A specimen of magnetite with iron nails attracted to it and a specimen of amber with bits of paper near by, with suitable notes explaining that magnetism and electrification are here

[1] This set consists of the following minerals: talc, gypsum, calcite, fluorite, apatite, microcline, quartz topaz, corundum and diamond.

shown, will serve as effective presentation of these properties and will intrigue many students.

Lastly, much interest is aroused in minerals (not to mention solid geometry) by completing the exhibit with a collection of celluloid models representing the six main types of crystal structure. Methods for preparing these models were discussed in an earlier member of this series.[2]

With all these considerations in mind, an exhibit was recently prepared at our school. Into one wall-case was placed a collection of minerals marketed by a well-known scientific supply house.[3] This collection consists of 36 specimens wisely selected by this firm both for variety and quality, many specimens being attractive because of their perfect crystal form, and others for their rich colors. Some of these minerals are known to occur in gem quality. In these instances friendly jewelers were kind enough to permit use of their stocks to enrich the display of the purchased minerals. These gems added very greatly to the effectiveness of the exhibit. For instance, a very beautiful set of nine amethysts of varying shades and polished shapes ("cabochon," "brilliant," "emerald," "pendeloque," etc.) and some beautifully cut crystal pendants and beads were shown along with the specimen of quartz. Two brilliant-cut topazes supplemented the specimen of that mineral. The corundum crystal was accompanied by three large and magnificent reconstructed rubies and several dozen emerald-cut synthetic sapphires. A large, brilliant-cut zircon, a subtle-shaded almandine garnet, a hematite bead, and a clear, amber bead were placed appropriately and the collection was rounded out by a series of polished specimens of the hydrated quartz minerals such as carnelian, onyx, sard, bloodstone, opal, chrysophrase, etc.

Under the title "Minerals—Mystery or Mastery?" was placed the following plaque: (See also Plate I).

The times are troubled and out of joint on our sorely tried planet. Nor is Nature's most highly endowed and adapted creature—man, to be held guiltless. See what turmoil he has brought about in the affairs that concern his dealings with his fellows! You will find abundance of greed, threats, tyranny and, as a grand climax, war with its four horsemen. So much for creation above the surface of the earth.

A look at nature's handiwork below the surface of the earth shows a differently ordered creation. How marvelous is the world of minerals—how orderly, how obedient to law, how beautiful! In this museum case you will

[2] "The Exhibit as a Supplementary Method"—"Crystallography"—SCHOOL SCIENCE AND MATHEMATICS, December, 1936.

[3] "Ward's Natural Science Establishment, Inc., Rochester, N. Y.

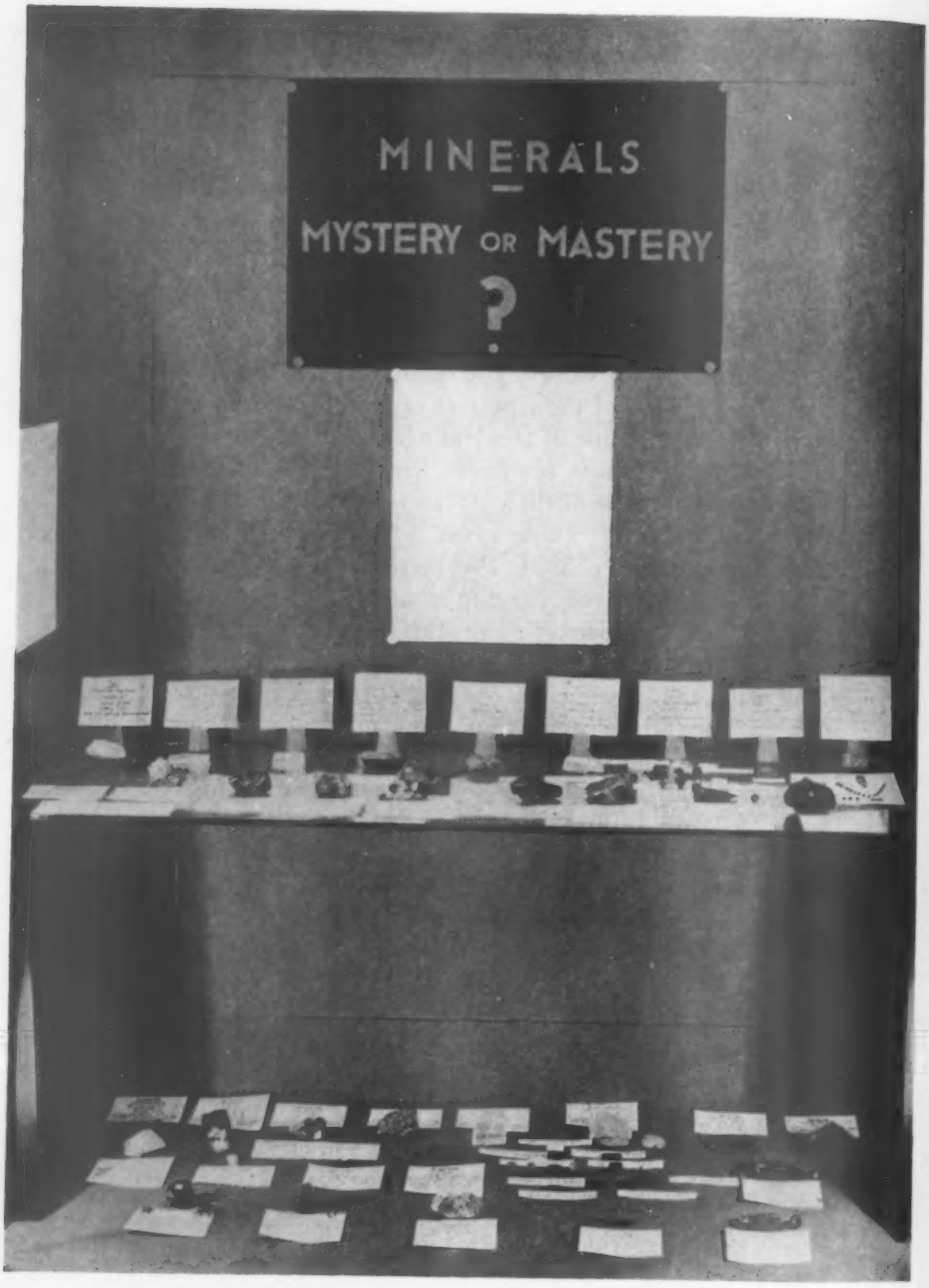

PLATE I. MINERALS—MYSTERY OR MASTERY.

see a collection of minerals intended for student use. Although these specimens have been selected because of their beauty and crystalline form, they are not extremely unusual specimens, but could be described as "high grade" and typical.

If you will examine the contents of the wall case at your right, you will learn how scientists bring their knowledge of minerals to the point of mastery. Without this knowledge minerals can be only a mystery.

From world affairs to mineralogy—from chaos to order—what a study in contrasts!

At the side of this portion of the exhibit was posted a list of the minerals on display and their chemical composition, as follows:—

CHEMICAL COMPOSITION OF THE MINERALS IN THIS WALL-CASE

1. Talc—magnesium silicate
2. Gypsum—calcium sulphate
3. Calcite—calcium carbonate
4. Fluorite—calcium fluoride
5. Apatite—calcium phosphate
6. Microcline—potassium aluminum silicate
7. Quartz—silicon dioxide
8. Topaz—aluminum silicate and fluoride
9. Corundum—aluminum oxide
10. Bauxite—hydrated aluminum oxide
11. Native copper—copper
12. Bornite—copper and iron sulphides
13. Chalcopyrite—copper and iron sulphides
14. Malachite—green copper carbonate
15. Azurite—blue copper carbonate
16. Pyrite—iron disulphide
17. Hematite—iron oxide
18. Magnetite—iron oxide
19. Limonite—hydrated iron oxide
20. Galena—lead sulphide
21. Sphalerite—zinc sulphide
22. Graphite—carbon
23. Halite—sodium chloride (table salt)
24. Rose quartz—silicon dioxide plus impurities
25. Flint—silicon dioxide plus impurities
26. Jasper—silicon dioxide plus impurities
27. Marble—calcium carbonate
28. Feldspar—potassium aluminum silicate
29. Augite—calcium and iron silicates
30. Hornblende—calcium and iron silicates
31. Crocidolite—magnesium and calcium silicates
32. Garnet—calcium aluminum silicate
33. Zircon—zirconium silicate
34. Tourmaline—lithium aluminum boro-silicate
35. Muscovite—aluminum iron silicate
36. Amber—a compound of carbon, hydrogen and oxygen

The second wall-case carried out the suggestions made in item 5 of this paper. Under the title "Physical Properties of Minerals" was placed the following plaque: (See also Plate II).

The mineralogist identifies his specimens by examining their properties, among which we may list (a) hardness, (b) cleavage, (c) fracture, (d) specific gravity, (e) transparency, (f) color or streak, (g) luster, (h) electricity and magnetism, (i) crystalline form.

(a) Hardness means resistance to scratching. Some minerals look very much like others but the determination of the hardness enables the mineralogist to distinguish between them. In the scale of hardness ex-

PLATE II. PHYSICAL PROPERTIES OF MINERALS.

hibited here, the minerals are so arranged from 1 to 10, that any mineral will be scratched by any other mineral of a higher number. Thus diamond, 10, will scratch all of the other minerals of this scale of hardness, but will be scratched by none.

(b) Cleavage is the property shown when a crystal breaks in such a way as to produce smooth surfaces in certain directions. Examples:—Halite shows cubical cleavage; mica, micaceous cleavage; and fluorite, octahedral cleavage.

(c) Fracture is the tendency of minerals to break unevenly. That of quartz is known as uneven fracture, as there seems to be no regularity in the type of break. Some minerals show a break quite similar in shape to that of a tiny oyster shell. This kind of fracture is called conchoidal, obsidian being an example.

(d) Specific gravity is a comparison between the weight of a substance and the weight of the same volume of water. This property is very important in detecting bogus gems.

(e) Transparency refers to the ability of a substance to permit light to pass through it. Quartz is transparent. Rose quartz is translucent, as objects cannot be seen clearly through it. Magnetite transmits no light and is said to be opaque.

(f) Color is interesting but deceiving, the important thing being not the color of a mineral, but that of the streak which it leaves when rubbed across a rough surface or streak-plate. Chalcopyrite is yellow in color but leaves a greenish-black streak. Hematite may be grayish black, but leave a brownish-red streak.

(g) Luster is the kind of shine shown by a mineral, and is very important in identifying a specimen. Luster that resembles the shine of a metal is called metallic luster, the other kind of luster being known as non-metallic. The non-metallic shine of quartz is known as vitreous (glass-like) luster, that of amber being known as resinous luster, while that of asbestos is known as silky luster.

(h) Electricity is shown by some minerals when they are rubbed on a piece of silk. If this is done to amber, it will pick up small pieces of paper, because it has become electrified.

Other minerals show magnetism. Magnetite will attract and hold iron nails.

(i) Crystals, by their beauty, fascinate most people. Although the variety of possible forms is infinite, crystals may be classified into six systems on the basis of the proportions of their axes and the angles at which these intersect.

1. *Isometric* or *regular system:* Three equal axes, at right angles to each other. Example: cube.
2. *Tetragonal system:* Two equal axes, and one longer or shorter, all at right angles to each other.
3. *Orthorhombic* or *Rhombic system:* Three unequal axes, all at right angles to each other.
4. *Monoclinic system:* Two axes at right angles and a third perpendicular to one and inclined to the other.
5. *Triclinic system:* Three axes, all inclined to each other.
6. *Hexagonal system:* Four axes, three equal axes in the same plane intersecting at angles of 60, and a fourth at right angles to all these.

Each of these groups is represented by a celluloid model in this show-case. Note that there are really six pairs of models, each model consisting of one inside another. The purpose of this is to show that the shape or size of a crystal is relatively unimportant in classifying it. The important thing is the relationship of the axes to each other, with respect to length and angles

of intersection. Thus you see that two crystals of as widely different appearances as the one inside the other may belong to the same group because their axes are identical. In these models the axes have been painted red, to make them more visible. They illustrate, however, only imaginary lines.

Note the quartz, corundum, and garnet specimens in this wall-case. They are excellent examples of crystalline form.

The last section, relating to crystals, was illustrated with drawings of the six main types, for purposes of comparison with, and study of, the models. (See Plate II, at right of plaque.)

Such exhibits can capitalize current interest in usually neglected fields and even make a contribution to the war effort by awakening interest in local natural resources. They also make a bow to such studies as history, economics, and geometry. But the genuine enthusiasm aroused by them is best ascertained from direct experience. To revive the flagging spirits of a teacher there is nothing better.

INFORMATION CONTAINED ON LABELS IN THE EXHIBIT

Name	*Locality Where Found*	*Variety*	*Hardness*	*Remarks*
Talc	Fullerville, N.Y.	"Soapstone"	1	Pearly luster; used for making talcum powder.
Gypsum	Wayne Co., Utah	"Selenite"	2	Pearly luster; used for making "Plaster of Paris."
Calcite	Big Timber, Mont.	"Iceland Spar"	3	Used in scientific instruments.
Fluorite	Rosiclare, Ill.		4	Color either green or purple; used as flux in open-hearth furnaces for making steel and for etching glass.
Apatite	Ontario, Canada	"Phosphate"	5	Luster vitreous and resinous; used as fertilizer.
Microcline	Ontario, Canada	"Feldspar"	6	Notice cleavage faces; used in making pottery.
Quartz	Brazil	"Rock Crystal"	7	Found in many different varieties; used in optical instruments.
Topaz	Brazil		8	Very valuable white, blue and brown topazes are found in Siberia.
Corundum	South Africa		9	Called *emery* when mixed with magnetite, *ruby* when red, and *sapphire* when colorless or blue; used as gem and abrasive.
Bauxite	Arkansas			Described as "pistolitic" because of its resemblance to peas, Latin for which is "pisum;" used as ore of aluminum.
Native Copper	Calumet and Hecla Mine, Michigan		under 3	Metallic luster; this mine is one of the deepest in the world—6000 feet.
Bornite	South Africa		3	"Variegated copper ore"; 55% copper.
Chalcopyrite	Arizona	"Copper Pyrites"	4	Metallic luster; streak greenish-black; (commonest copper ore—34%).
Malachite	Belgian Congo		4	One of the most fascinating and beautiful minerals known; used for pillars, wainscoting, table tops and gems; 57% copper.
Azurite	Arizona		3.5–4	Both azurite and malachite are copper carbonate; copper 55%.

Name	*Locality Where Found*	*Variety*	*Hardness*	*Remarks*
Pyrite	Missouri	"Fool's Gold"	6	Gold has a golden-yellow streak, while that of pyrite is nearly black; gold can be scratched with a knife blade (hardness 3) while pyrite cannot (hardness 6).
Hematite	England		6	Most important iron ore—70% iron; found in red and in black varieties but both have red streak; 36,000,000 tons mined in one county in Minnesota in 1929; cause of color of red rocks in Grand Canyon.
Magnetite	California	"Lodestone"	6	Streak black; a magnet is strongly attracted to it; best ore of iron—72%.
Limonite	North Carolina	"Brown Iron Ore"	5	Streak brown; it has changed to limonite on the outside and now mimics pyrite.
Galena	Oklahoma	"Lead ore"	5	Luster metallic; streak gray; cleavage cubic; always breaks into cubes whenever broken up.
Sphalerite	Oklahoma	"Zincblende"	4	Luster resinous; varies so widely in appearance that its name is from Greek, "treacherous."
Graphite	Ceylon	"Black lead"	1–2	Soft enough to be used for writing yet is made of same element as diamond i.e.—carbon.
Halite	Germany	"Rock salt"	2.5	Cleavage cubic; taste salty; life would be impossible for us without this mineral.
Rose Quartz	South Dakota		7	Vitreous luster; translucent; conchoidal fracture; semi-precious variety of the commonest mineral—quartz.
Quartz	Dover, England	Flint	7	American indians used it for arrowheads, striking fire, etc.
Quartz	South Africa	Jasper	7	Used as semi-precious stone for thousands of years (seal-ring stones, etc.).
Calcite	Colorado	Marble	3	Marble from this locality used in Lincoln Memorial in Washington; once limestone but heat and pressure formed crystals.
Orthoclase	Nevada	"Feldspar"	6	Note crystalline form.
Pyroxene	Bohemia	Augite	5.5–6	Many varieties of augite are known; this crystal is very typical.
Amphibole	Canada	Hornblende	5–6	Similar to pyroxene, but the faces of this mineral form a hexagon while those of pyroxene meet at right angles.
Crocidilite	South Africa	"Blue asbestos"	6–6.5	Often completely altered to quartz by nature; then used as semi-precious stone called "tiger-eye."
Garnet	Alaska		7–7.5	Harder than quartz; therefore used as abrasive transparent variety used as gem.
Zircon	North Carolina		7.5	Note that this crystal is a square prism terminated by a square pyramid; used as a gem and in making gas mantles.
Tourmaline	California	Rubellite	7–7.5	Crystal in threes or sixes; occurs in green, brown, black, yellow, orange, white and colorless.

Name	*Locality Where Found*	*Variety*	*Hardness*	*Remark*
Muscovite	North Carolina		2.5	Used in electrical appliances, to give sparkle to wall-paper, lubricant, etc.; has remarkable cleavage.
Amber	Germany		2.5	Esteemed from ancient Greek days; electrical properties were known by Pliny; used for beads, cigar-holders, etc.

AMERICAN ASSOCIATION OF JUNIOR COLLEGES

Believing that its patriotic duty is to lessen where possible the country's increasing transportation problems during wartime, and aware of the necessity for economy in time and money, the American Association of Junior Colleges has decided to cancel its annual meeting this winter, according to vote of the Executive Committee of the association just announced at Washington. Instead of the one national meeting previously scheduled for St. Louis March 4–6, six regional meetings will be held at points convenient to junior college administrators in the areas covered by the six regional junior college organizations, thus assuring attendance of a much larger number of representatives of the more than 600 junior colleges of the nation than would be possible under wartime conditions if a single meeting were held.

According to readjusted plans, these six regional meetings will be held this fall and next spring. The groups meeting this fall and their places and dates of meeting are as follow: Junior College Council of the Middle States, New York City, November 28; Southern Association of Junior Colleges, Memphis, December 1; and New England Junior College Council, Boston, December 5. Groups meeting in the spring are: North Central Council of Junior Colleges, Chicago; Northwest Association of Junior Colleges, Spokane; and California Junior College Federation, in or near Los Angeles.

It is planned to have Dr. Walter C. Eells, executive secretary of the American Association of Junior Colleges, attend all six of the regional meetings to unify the discussions and activities of the various groups. Dr. John W. Harbeson, president of the association and also president of Pasadena Junior College in California, plans to attend both the Memphis and California meetings.

NEW GLASS-TO-METAL SEAL

The problem of making a vacuum-tight seal between metal and glass, such as for the lead-in wires of an electron tube, received a new solution in the invention of George Robert Shaw of Verona, N. J., who is the recipient of U. S. Patent 2,298,974. He has assigned the rights to the Radio Corporation of America.

The new method permits use of a metal having a very different heat expansion from that of the glass. All previous methods have sought to find a metal having the same expansion, platinum, nickel-steel, or to develop a glass that would have the same expansion as the metal.

The inventor impregnates or coats the metal with gas producing substance. When heated in the sealing process, the gas is generated and fills the glass near the surface with bubbles. This forms a sort of cushion between the metal and the more solid glass beyond.

SCIENCE ON THE MARCH

JUNIOR ACADEMY RADIO SCRIPT

JOHN J. COCHRANE*

Austin High School, Austin, Minnesota

Music

Announcer: Ladies and Gentlemen. Science on the March!

Music

Announcer: We bring to the students and faculty of the Academy of Science a broadcast of *science progress.*

This morning we take you to a meeting of the Junior Academy of Austin High Schoool. The meeting has been called to order by the chairman. We will fade in on the discussion which is now underway. . . .

Chairman: Science and its tremendous flight of progress through war and peace has been especially evident in recent months. This morning we will hear briefly from some of our members who have become especially conscious of current scientific achievement.

War-time secrecy has enveloped many branches of science. A day will come when their work of the present may be used for better living during peace-time. Today we have selected some of the things which can be told! Consider just a few of the well known advances of the past seventy years. Now prominent are the automobile, motion pictures, the X-ray, electric light, radium, radio, airplane, and telephone. The telephone for example, was introduced commercially just 65 years ago. 42 million telephones knit the world together at the present time. John, what have you to say about all this progress?

John: Science has certainly made problems, but it has solved many too. This progress you speak of *has* and *is* changing our world, and very rapidly. Why, the March of Science reads like the March of Time! Listen to this:—

"A new microscope magnifies 30,000 times!"

"Doctors are saving more lives than ever before!"

"Molasses, grass, seaweed, and a few other humble growths are converted into coal and oil!"

"September and October, New York sport fans saw their favorite programs by television!"

* Mr. Cochrane is now at the Roosevelt Junior High School, Rockford, Ill.

"The world's largest telescope soon to be finished will view stars a billion light years away."

"Uncle Sam's 16 inch coastal guns now fire projectiles 28 miles!"

"Synthetic wool and silk have crept into the nation's wardrobes!"

Chairman: (interrupts in same tempo)

"Chemists are brewing plastic planes in test tubes!"

Ah! Yes! Science certainly is on the March! I'm interested in these plastics. What has been done in this field, Shirley?

Shirley: If all the new cars of 1942 were one, *it* would have 120 plastic parts. Certain models carry 75. Plastics are even taking the place of cog wheels. An all plastic automobile body has now been completed. The panels are made from wood pulp, flax and hemp threads, mixed with plastic syrup. This plastic syrup is a mixture of soybean meal and carbolic acid. The windows and windshield of the car are of a clear, tough plastic that is used in bomber planes. Lucite covers the instrument board.

Chairman: That is interesting, Shirley. It suggests the fiberglass discovery which was made quite accidentally in 1932. What is being done with this glass today, Cliff?

Cliff: Latest uses are for airplane wing coverings, insulation for electric wires, and cloth for dresses. Fireproof draperies for hotels, theaters, and homes may be fiberglass.

Chairman: How is it made, Cliff?

Cliff: By melting glass marbles and blowing the liquid through holes, filaments are formed. Each filament is 20 times finer than human hair. One pound of glass makes 10 million yards or more than 5000 miles of a single filament.

Chairman: Glass is now being used in a secret way for new parachutes. Aviation improvements have been among the greatest. Just 39 years ago the Wright brothers made their first non-stop record flight of 120 feet in 12 seconds. This started aviation on its march. Marvin, anything new in aviation?

Marvin: Plenty! War planes of this nation's winged might have reached a speed above 500 miles an hour. Self-sealing compounds are now placed in linings of fuel tanks and hoses. Aircraft production has been speeded up by improved techniques in welding and riveting.—Just to mention a few!

A 70 ton flying boat, the Martin Mars was launched into both air and water. Its wing spread is 200 feet. This amphibian can fly across the Atlantic and back again without stopping.

Some queer designs are appearing. The "flying wing" is one which has no tail. Its one large wing is 38 feet from tip to tip. The propellors point backward.

One plane is reported by reputable authority to have been flown without propellors. It is driven by a jet of air. In a test flight it averaged 130 miles per hour. New bomber detectors would have to be devised for this job.

Chairman: Many high school students are helping on *one aviation* project. Tell us about this, Elizabeth.

Betty: More than 26,000 high schools are building models of war planes for use in training Navy personnel. These model-makers learn a great deal about airplanes as they help in the war effort.

Chairman: All branches of science are on the march.

We have vitamin research, anti-serums and influenza vaccine, the life saving "sulfa" drugs, fluorescent lighting, and the cyclatron. Uses of the photo-electric cell would fill a large volume. Airplane detectors using radio echoes have been drafted, and a telephone cable is in the service which carries 480 conversations at the same time on one pair of wires.

Betty, any report on the X-ray?

Betty: Yes, as a matter of fact, it has some new patients. Diagnosis of faulty telephone poles, tires, and metal braces are now possible with the X-ray. A million volt machine will X-ray 4″ of steel in two minutes.

Chairman: In this brief scan of progress we have mentioned the automobile and the airplane, but what about the railroad? Has this field of transportation been neglected, John?

John: This will answer that question. It is claimed that in the past 15 years the railroads have spent over 10 billion dollars for improvements. Newest major improvements are the diesel-electrics. A diesel engine runs a dynamo to furnish power for the motors of the wheels. Twenty years ago trains averaged about 35 miles per hour. Today 8 blue ribbon trains average 60 miles per hour on average runs of 600 miles.

Last summer the *heaviest* and *strongest* locomotive in the world was delivered. It weighs 596 tons. During each hour of heavy work, it burns 12 tons of coal and boils 15,000 gallons of water, It pulls with the power of 100 automobiles, and can run at 80 miles per hour.

Chairman: Now, going swiftly into another field let us check on the "rubber problem." Chemistry departments in many uni-

versities are working day and night to uncover more about natural and synthetic rubber. Cliff, have you any information on this?

Cliff: Yes, such synthetic rubber products as buna, neoprene, and Ameripol make excellent imitations of rubber. At the present time synthetic rubber costs more than natural rubber—that is, if you can get natural rubber! Authorities have stated that no satisfactory tires have been made entirely of synthetic rubber.

There are 1000 plants which are known to contain rubber. Most familiar is the guayule (gwa-yoola) shrub of the west. This plant has long been used as a source of rubber. Prominent scientists and citizens have backed a bill in congress to provide money for planting 45,000 acres in this wild rubber producing shrub.

Chairman: In this kaleidoscopic parade of scientific progress we have seen more than 20 notable contributions to our world of today. We have observed the mammoth field of scientific discovery, research, and invention powerfully at work on problems of the moment.

That is why we say—SCIENCE IS ON THE MARCH!

Music: Fade out.

Announcer: This concludes the Austin High School Broadcast. Thank You.

WAR INDUSTRIES DEPEND UPON EDUCATION

Since July 1940 over 3,000,000 persons have received training leading directly to employment in war production. The tempo of this program must be and will be steadily increased. It now involves about 1500 centers and 2150 schools giving pre-employment training, 1300 schools giving supplementary training, and 138 colleges giving training in science, engineering, and the management of war production.

Although this training usually culminates in special vocational classes, it is directly dependent upon general education, good work habits, and broad mechanical skills. These foundations are laid in the elementary and secondary schools. Guidance and counseling services help young people to select the occupations which are most important in the war economy and which most fully utilize their talents. The basic general education, wise guidance, and special training are all necessary if a steady flow of skilled workers is to move into the essential war industries.

Special scientific training is necessary for the success of the technical branches of the armed services and for the war industries. Scientists and technicians of many kinds must be prepared. Here, too, it is important to remember that advanced technical training can be built only upon proper preliminary training. In order to maintain a steady flow of technically equipped persons into the fighting forces, agriculture, and the war industries, effective preliminary training in the elementary and secondary schools must be maintained.

—THE SUPPORT OF EDUCATION IN WARTIME

CONTRIBUTIONS OF MATHEMATICS IN THE DEVELOPMENT OF ART

A. Reid Winsey
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A spectator walking into the Indiana building of the Chicago World's Fair of 1934 found his attention irresistably drawn to the murals devoted to Indian life. From that point on, the spectator was carried through a series of episodes depicting the chronological history of Indiana. His eyes were moved from picture to picture in the direction that the artist desired. And this was accomplished through the artistic application of mathematical and scientific principles. There was great art in those murals of Thomas Hart Benton and the creative spirit of the artist was made more effective through careful preliminary planning.

Many artists use a very definitely planned mathematical approach to their paintings. They believe that a picture must be as carefully organized and executed as a military maneuver. The artist cannot simply start at the top of the canvas and work down as far as he likes. Nor does he wait until he has received that creative inspiration which drives him to dash up to his garret studio to knock out a masterpiece. While he will routinize his work and hope for exceptional stimulations, yet he is not limited in his production by the technicalities of science or mathematics. His training in both of these fields has given him a background for almost unconscious mastery of the mechanical problems in art.

Research in the history of art reveals that mathematics played an important role in the creations of the Assyrians, the Egyptians, the Greeks and the Orientals. In Assyrian art and architecture, the decorations were harmoniously proportioned to the surfaces and areas of buildings. The Egyptians applied the use of mathematics to their art and architecture by establishing definite rules of proportion and measurement. Through the use of rope-stretching in re-surveying flooded lands, they developed concepts of geometry and applied these principles to their art. The classical masterpieces of the ancient Greeks have

been studied for five hundred years in an effort to find the mathematical formulae basic to their flawless structures. Oriental art has also been subjected to similar research. Artists are convinced of the need for a thorough understanding of mathematics that may apply to art.

With the fall of the Roman civilization by 476 A.D., practically all paintings were lost to the world and only the masterpieces of architecture and sculpture remained as an inspiration to artists. And with the destruction of paintings by barbarians and iconoclasts, the technical principles involved were also lost. Prior to the Renaissance of the fourteenth century, the only paintings in existence were the crude, flat, stereotyped, monotonously symmetrical works of the early Christian and Byzantine painters.

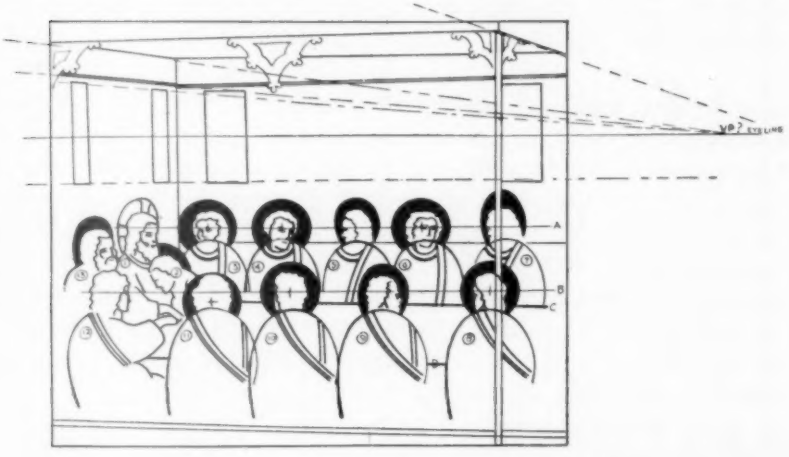
The Renaissance brought interest in life and men attempted to transfer the inspirations they felt toward their environments from their minds and spirits to artistic media. They decorated the walls of their churches with religious representations. They bought pictures for their homes as we buy motor cars. Their public buildings were so decorated with sculpture and paintings that the common man became a connoisseur of art. Scientific research in art developed an understanding of the technical aspects to an unparalleled degree.

The outstanding contributions of mathematics to the art of this period were the laws of linear or pictorial perspective, geometric construction, human proportions, atmospheric perspective, light and shade, and foreshortening. A study of the paintings of four representative artists of the Renaissance will summarize the technical development of that period. They were as follows:

Giotto	1266?–1337	Florence, Italy
Uccello	1396?–1475	Florence, Italy
Francesca	1416 –1492	Umbria, Italy
da Vinci	1452 –1519	Florence, Italy

Giotto marks the beginning of the effort to recover the use of mathematics in art. Departing from the Byzantine stylized arrangements, he attempted to represent man and nature in third dimension. This can only be done accurately with a knowledge of pictorial or linear perspective. While he did not develop adequate rules for perspective, yet his pioneering endeavors created a need for mathematical principles. However, he succeeded in breaking the tradition of the flat, symmetrical picture. For ex-

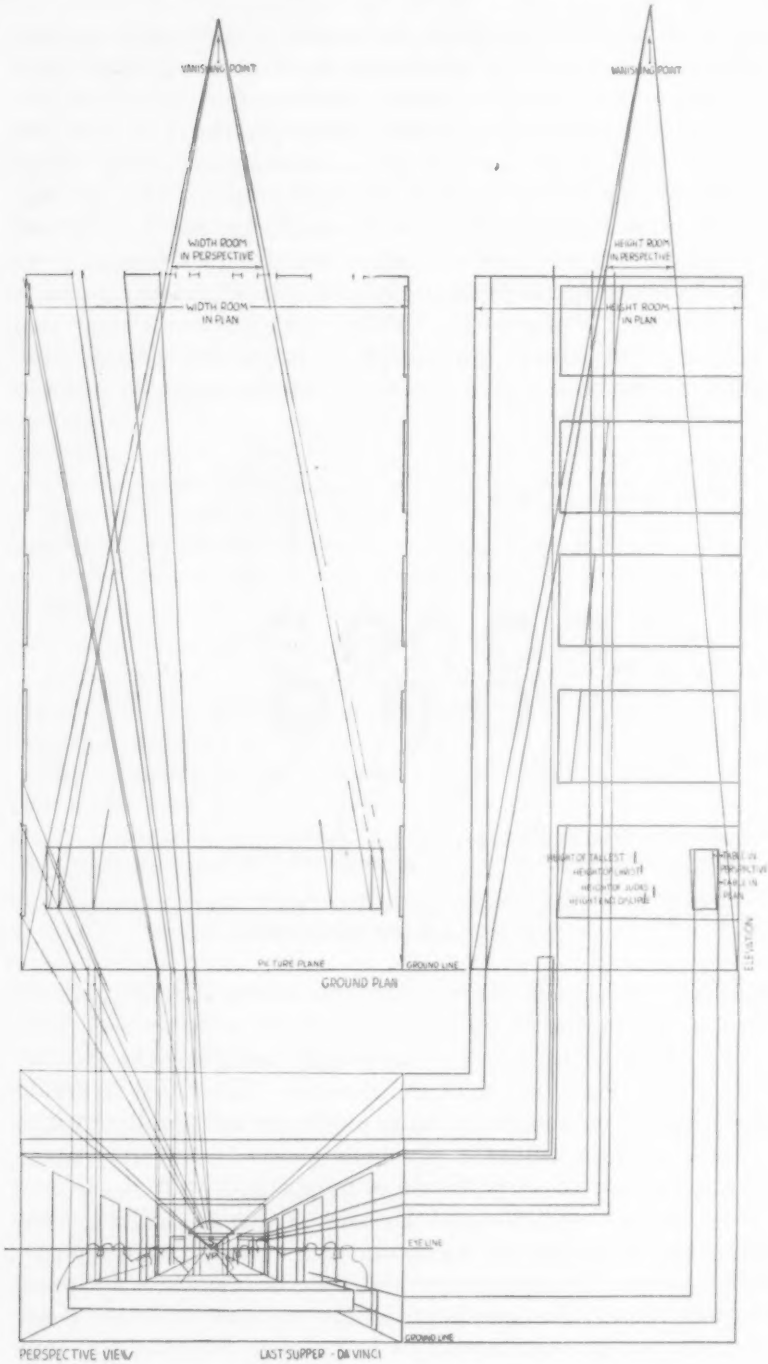
ample, in his *Last Supper* we see traces of the traditional emphasis on symmetry through repetition of certain disciples. Yet he broke all traditions by placing Christ at one side of the picture. This off-balance arrangement developed the need for a new type of composition and the use of mathematics in directing centers of interest. Giotto was not highly successful in leading the spectator's eye to Christ even though he gave him a different type of halo and turned several of the disciples toward him. Analysis of this picture fails to reveal the use of vanishing points or eye-lines. Consequently, Giotto's picture is not over two yards in depth. Also, in presenting the backviews of haloed disciples, the nimbuses were painted in as flat circles in front of



Analysis of Linear Perspective in the Last Supper by Giotto. Example of Early Renaissance.

their faces preventing them either from eating or seeing. He did not understand the use of the ellipse. In showing the side view of a roof over the table, a supporting column cuts directly through the head of one of the disciples. His efforts to create third dimension brought up many mathematical problems which he was unable to solve.

Solutions for these problems of perspective were discovered by the great research artist Uccello. Although he had many opportunities to become a popular and wealthy painter, he insisted on spending his energy and time in relentless, technical analysis of pictorial perspective. His success in locating the vanishing points of a seventy-two faced polyhedron was only


VANISHING POINT
VANISHING POINT
WIDTH ROOM IN PERSPECTIVE
WIDTH ROOM IN PLAN
HEIGHT ROOM IN PERSPECTIVE
HEIGHT ROOM IN PLAN
PICTURE PLANE
GROUND LINE
GROUND PLAN
ELEVATION
EYE LINE
GROUND LINE
PERSPECTIVE VIEW
LAST SUPPER - DA VINCI

one of the inutterably complex problems he undertook. There is no painter, architect, industrial designer, landscape gardener, commercial or fine artist who is not indebted to Uccello. In his painting, *The Rout of San Romano*, he perfectly illustrates the application of his mathematical formulae. The fallen warriors and broken lances in this battle picture all lie along the directions of the vanishing lines and in foreshortened construction. The drawings and paintings of Uccello became mathematical textbooks for the painters of the Renaissance. But it remained for Piero della Francesca to record and develop Uccello's ideas. Francesca's textbook, *De prospectiva pingendi*, became a practical handbook for artists in training. And his pupil, Luca Pacioli, contributed two texts on the use of mathematics in art. They were *Summa de Arithmetica*, Venice, 1494; and *De divina proportione*, Venice, 1509.

The culmination of artistic progress in the Renaissance can be found in the work of the genius Leonardo da Vinci. He combined a thorough understanding of the laws of mathematics and science with that spark of inspiration that creates masterpieces. Perhaps his greatest contribution to art comes from his research on the human figure. By actual measurement of human proportions and the dissection of cadavers, he arrived at a group of laws governing the construction of the body. His drawings are studied by many medical students today. In the utilization of the principles of geometric construction, he was surpassed only by the master of all composition, Raphael. Leonardo made an outstanding application of aerial perspective in the background of his world-famous picture, *Mona Lisa*. This master of all that was art contributed studies in light and shade that are used today by students. His notebooks contain a remarkable record of the mathematical problems faced by artists.

An analysis of Leonardo da Vinci's *Last Supper* is proof of the value of mathematics as applied to linear perspective. All the lines in this picture converge to Christ's head, the center of interest. In order to study the accuracy of the pictorial perspective in this painting, projections of the ground plan and elevation were made from a print. These projections furnish undeniable evidence that the painting was developed with a full knowledge of mathematical perspective and that the principles were applied with exactness. This reversed process of developing projections in perspective offers an interesting check on the mathematical accuracy of any painting. The perfection of

Leonardo's work is especially apparent when it is compared with the same subject as painted by Giotto. In Giotto's *Last Supper* it is impossible to locate the vanishing points and eyelines, while in da Vinci's, they are obvious.

The major discoveries in art since the Renaissance have been made in the field of color and color theory, but additional research has been carried on in color-in-light, composition, light and shade formulas, abstractions, and functional design. Each of these areas will be treated briefly.

Color and Color Theory

There have been literally dozens of color theories, charts, wheels and color formulae created for the use of artists in the commercial and fine art fields. These devices are highly technical approaches to the use of color relationships and they aid the artist in being more consciously aware of harmonies possible among the multitudinous tints and shades. Formulae are also offered for intensities or concentrations of color and each formula is based on a different theory; for example, the Munsell color theory is based on five primary colors whereas the Prang theory is founded upon three.

Color in Light

The discoveries of color in light as applied to painting has tended to break down the old theories of light and shade. This theory is based upon the prismatic separation of white light and formulae are offered to produce color harmonies without the use of darks and shadows. This theory is a contribution of the school of Impressionism.

Composition

Modern artists have expended great energy in analyzing the mathematical basis of ancient and Renaissance art. Teachers of art, such as Jay Hambidge and Maitland Graves give us rather definite formulae for appreciating and creating artistic compositions. They offer the theory that there are certain proportions that are most pleasing to every eye. Hambidge, for instance, believes that the architecture of nature as represented by the plant and the architecture of man are intimately related through the concepts of dynamic symmetry. Hambidge's[1] treatment of art problems should warm the mathematician's heart. By use of the Fibonacci summation series, he shows that living, growing

[1] Hambidge, Jay *The Elements of Dynamic Symmetry*, Brentano's, N. Y., 1926.

nature functions according to mathematical laws. Perfect harmony and dynamic symmetry are to be found in the patterns of seeds in sunflower heads and in the discoid shell whose curvature is based on Bernoulli's logarithmic spiral.[2] Thus a definite measureable relationship is shown between the art of nature and man. The geometric progression 1, 2, 3, 5, 8, 13, 21, 34, 55, 89 . . . and the substitute series 118, 191, 309, 500, 1309 develop the approximate constant factor 1.618 which is known as the Golden Mean and the basis for perfect proportions.

Abstract Art

A complete departure from realistic subject-matter and representation has been attempted in what is now known as abstract art. The abstractionist relies almost entirely upon his knowledge of the technical aspects of art to gain emotional effects. He simply uses mass, line, colors, shapes, and geometric configurations and their interrelationships to present his ideas and feelings. His whole art is absolutely dependent upon a mastery of formulas and a knowledge of the psychological reactions of observers to these principles.

Functional Design

Streamlining or functional design is based upon the complete simplification of the art object for utilitarian purposes. It demands that the artist subordinate all artistic principles to the usage of the object. He has made a conscientious effort to ignore all decoration or ornament that does not conform to the structure and function of the work. Since mechanical considerations predominate the artist is naturally directed by scientific and mathematical principles. Functional design has become the artistic motif of our technological civilization.

Return to the Primitive

While the artist is eternally grateful to the mathematician for his aid solving technical problems, yet the modern emphasis on the mathematical and mechanical aspects of art is having an interesting effect. There seems to be a revulsion among many artists against the overabundance of science and mathematics involved in art training. This school of thought has attempted to reject or ignore all accepted principles of art and revert to the simplified, primitive art of the Pre-Renaissance period. And on

[2] Graves, Maitland, *The Art of Color and Design*, McGraw-Hill Book Co., N. Y., 1941.

our gallery walls today we find the same crude, flat, stereotyped, monotonously symmetrical, Byzantine prototypes which their creators call "original."

For this development, you mathematicians are not responsible!

In fact, the modern mathematician should be commended for his excellent use of art illustrations in the teaching of mathematics. A recent analysis of arithmetic, algebra and geometry textbooks reveals an enlightening application of mathematics to painting, sculpture, architecture and design. This trend toward a progressive coordination of mathematics and art is one that all educators should be happy to encourage.

ORGANIZED LABOR LOOKS AT EDUCATION

The American Federation of Labor held its 62nd annual convention in Toronto last week. Its Executive Council had this to say on child care and teachers salaries:

1. *On child care:* "There is a large group of working mothers whose young children are not being adequately cared for during their working hours. Increasing numbers of 'latch key' dhildren must unlock an empty house and prepare their own meals after school hours. Such gross neglect will inevitably be reflected in the growth of juvenile delinquency, a problem which we faced during the last war and which is serious in England today. . . .

"Community programs for day-care of children, supported by state leadership and guidance and by Federal assistance where necessary, are imperative in areas where mothers are being employed in war work. A 'Committee for the Care of Children in Wartime' should be formed in each community."

2. *On teachers salaries:* "As war takes an increasingly greater share of national income there is growing danger that many states will not be able to make adequate appropriations for schools. This is already happening in the states with low per capita income. . . .

"Shortages in teachers is a critical factor in our educational situation. These shortages largely grow out of the low salaries generally paid teachers.

"With our 16 per cent increase in cost of living these low-paid teachers are turning to industries and to the Government for a chance to earn a decent living. Until better salaries are paid teachers, we shall continue to lose trained persons to better-paying positions."—*Express News Letter.*

TENT IS ALSO LIFE PRESERVER

A shelter-tent that is also an emergency life preserver is the product of two Washington inventors, Comdr. E. C. Craig of the Navy and Glen W. Leyde, who have several other inventions already to their credit in the field of rubberized fabric products. Their present invention, covered by patent 2,299,078, contemplates a tent made of a moderately thick layer of expanded cellular rubber covered on both sides by duck or canvas. It is permanently closed on one end by a vulcanized seam, and the entrance can be snugly secured by a slide fastener with pull-tabs on both sides.

A SUMMARY OF PERIODICAL LITERATURE DEALING WITH TEACHING AIDS AND DEVICES RELATED TO THE TEACHING OF CHEMISTRY

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INTRODUCTION

A substantial number of articles may be found scattered through periodical literature which deal with teaching aids and devices related to the study of chemistry. Certain of the teaching aids and devices are worthy of use continuously during the time spent in consideration of the particular topics to which the teaching aids and devices are related. Others may be considered effective for occasional or intermittent use to stimulate or increase interest in the study of chemistry or to assist in providing lucid explanations of topics under consideration.

Frequently, effective teaching aids and devices available are not utilized by teachers of chemistry. This is due to assumptions by teachers of chemistry who, through long study and experience with the field of chemistry, have erroneously concluded that the explanations of certain topics are as clear to their students as they are to them or to the belief that since they are so deeply interested in the study of chemistry their students are likewise imbued with an equal interest in the study of the subject and therefore do not need artificial stimuli.

Even the high ranking student may be stimulated or be provided with a clearer understanding of topics under discussion through the effective use of appropriate teaching aids and devices.

PHILATELY

Many people are interested in the avocation of stamp collecting. Within the age limits represented by high school and college students, a fair proportion of students are interested in stamp collections and in stamp collecting. Schaeffer[1] furnishes a description of and discusses the types of stamps which may be mounted and used to aid in developing interest in chemistry. Fulforth[2] points out that many chemical facts may be brought out through the study of stamps. To recognize stamps which may aid in the teaching of chemistry, the stamp collector must be alert since usually stamps do not have labels or titles.

Charts, Graphs, Drawings, Scrap Books, and Displays

Beginning students of chemistry frequently forget to include the correct number of atoms of the compound involved in a percentage composition problem. Cope[3] suggests a useful chart which should be of value in assisting the novice in visualizing the proper solution of percentage composition problems.

In the study of chemistry, learning may be facilitated through the teaching of relationships rather than through the study of separate chemical compounds. A chart designed to graphically illustrate the value of the study of chemical systems rather than the study of separate chemical compounds in the class or lecture room has been suggested by Vandevelde.[4] Biefeld[5] described a chart which may be used to illustrate flow diagrams, curves, tables, and apparatus sketches used in the study of qualitative analysis for the purpose of affording opportunity for comparisons and contrasts.

For the purpose of clarifying theoretical discussions, graphs may be used to bring to the student a more complete understanding of the chemical theory involved. Wellings[6] advocates the application of the graphic method to the teaching of the gas laws so that the visualization process may permit the retention of the meaning of the laws long after the exact wording of the laws have been forgotten.

Through many years, teachers of chemistry have been of the opinion that the use of drawings in laboratory reports or term papers have definitely contributed to a more detailed and exact knowledge of the process studied. Heether[7] is of the opinion that clearer explanations are stimulated by neat drawings. As a means of securing neat drawings, he recommends the use of celluloid stencils containing cut-outs of important pieces of chemical apparatus. Chemistry teachers, charged with the responsibility of supervising laboratory instruction, work diligently towards the objective of developing the knowledge and general use of correct laboratory techniques in the courses in elementary chemistry. To those teachers of chemistry who, occasionally in moments of despair, regard this goal as a distant one indeed, the method of stimulating interest in correct laboratory techniques through the use of drawings illustrating incorrect set-ups posted on a bulletin board as suggested by Diwoky and Lewis[8] may assist in accomplishing the desired results.

For the purpose of assisting in the development of the habit of reading scientific literature and in stimulating a more active

interest in the field of chemistry, Chiddix[9] recommends requiring each chemistry student to keep a chemistry scrap book.

Students may be easily interested in tangible projects. In other words, interest is readily aroused by projects which may be exhibited when completed and by projects which enable the student to see and appreciate the fruits of his labors. Southern[10] recommends the use of displays, consisting of chemical compounds with their preparation, properties, and uses, prepared by chemistry students as a method of instruction. In addition to developing interest, the student secures a more intimate knowledge and understanding of chemical processes and chemical reactions, an appreciation of the relationship of chemistry to their every day life, and an appreciation of the contributions of chemistry to this scientific age in which we live.

Valence, Formulas, Nomenclature, and Symbols

The difficulties involved in teaching beginning students of chemistry, particularly those possessing mediocre ability, the fundamental concepts of valence, construction of formulas, equation writing, and ionization have long been recognized by teachers of chemistry. Bryan[11,12] describes the use of valence blocks, upon which he has secured a patent, in teaching the above mentioned concepts through visualization and construction methods. The blocks which may be fitted together to illustrate the desired concept may be secured in large size demonstration models for classroom use as well as in smaller models for individual use. Braille labeled blocks may be used for teaching blind science students.

An interesting method designed to assist beginning students to grasp chemical formulas and nomenclature has been advanced by Coulson.[13] This method introduces the use of flash cards into the teaching of chemistry. Flash cards, long used by teachers of arithmetic, reading, and spelling in the elementary school, are now called upon by chemistry teachers to assist their students to more easily and rapidly acquire the formulas and nomenclature required by the study of elementary chemistry.

Hackh[14] discusses the use of structure symbols as an aid in teaching. Although largely adaptable to the teaching of organic chemistry, he points out that the advantages involved in the use of structure symbols are accuracy, clearness, compactness, simplicity, and exactness.

Films, Slides and Projection of Experiments

Instead of haphazard use of industrial films in the classroom, Walters[15] presents a plan whereby the industrial films are scheduled in advance for the semester, used as an introduction to the subjects they are to illustrate, and suggests that industrial films are best used for teaching the applied portions of the course. Teaching students the proper weighing techniques in connection with the use of an analytical balance must, of necessity, be carried on with quite small groups. Durban[16] suggests the use of a 16 mm. motion picture film in connection with the teaching of weighing techniques so that the essential details may be presented simultaneously to the entire class. He believes that, in addition to the decrease of time required to teach weighing fundamentals, the techniques will be more effectively as well as more interestingly taught.

Assistance with the problem of overcoming the use of faulty techniques in the chemical laboratory may be secured by the adoption of the plan advanced by Levelle.[17] Several times a year, he shows his students prepared slides consisting of actual photographs of apparatus in use in correlation with laboratory technique lessons.

Fillinger[18] has suggested the use of an opaque baloptican projection lantern for the purpose of insuring visibility of details of lecture experiments to each member of a large class. The author also suggested that experiments such as relative degrees of ionization of acids and bases, suppression of ionization of weak acids and bases, fractional precipitation, and double refraction of Iceland spar be used.

Atomic and Molecular Models

VanValkenburg[19] describes the details and directions for the construction of a new atom model. The model may be used in demonstrating positive and negative valences, transferring and sharing of electrons, the periodic law, alpha and beta particles or isotopes, and the packing effect of ions.

Robey[20] discusses the preparation of molecular models for use in the study of inorganic chemistry from models used in organic chemistry or from common materials at relatively low cost. The demonstration of many types of isomerism of inorganic coordination compounds may be effected by these models.

A comprehensive discussion of the types and uses of atomic and molecular models in the teaching of chemistry was given by

Pouleur.[21] Demonstration of electron transfer, valence exchange, molecular and compound formation, and weight proportion were some of the indicated uses.

Chemical Games

Chemical games may be used for instructional purposes as a means of injecting interest into the proceedings during a regular class period or as a means of introducing novelty into an otherwise mechanical and frequently uninteresting review lesson. Chemical games have their definite place on the program of chemistry club meetings as an entertainment feature. Wolf[22] describes a game which requires the student to recognize various substances on the basis of color. Brown[23] proposes a chemical card game similar to Flinch. At the top of the card is placed the symbol of an element or group. Below it is found the chemical name while the valence is placed in the left hand corner of the card. Formulas, chemical names, and trade names of salts of sodium occupy the middle half of the card while the name of the acid to be used is found on the lower half of the card. Tormey[24] has advanced the suggestion of using a chemical baseball game. Sides are chosen and runs are scored in accordance with the rules of the game. Sparks[25] introduces the suggestion of a chemcal game based upon chemical atoms or ions as units. Cards are used to play the game. The symbol of an element or radical is placed at either end of the card. The valence and atomic weight are found near the center of the card.

Miscellaneous

The daily calendar, commemorating birth or death anniversaries of individuals prominently identified with chemistry and its related fields, constructed by Huntress[26] should be an effective teaching tool in developing and sustaining interest in the field of chemistry and providing the student with an exceptional background in the history of chemistry. Barrus[27] describes inexpensive models which may be used to illustrate formulas and chemical changes through the use of "Tinker Toys." Teachers of chemistry that have attempted to secure films or slides of new processes within a reasonable time after their introduction will undoubtedly agree with the position taken by Astell[28] who suggests that studies should be developed with a view of determining what visual and other aids are necessary to keep abreast with the changing conception of curriculum content.

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WHERE TO BEGIN TEACHING MAP SKILLS?

Skill in reading maps is important to the layman for keeping up with the world today. To the soldier and sailor it is vital.

Since map-reading training is so important for every individual, where should it begin in our schools and how should it be treated? Too often, it does not begin until children are in the middle grades, and then they are presented unceremoniously with a geography textbook that requires them to read complicated political maps even grown-ups find difficult. No wonder the youngsters sometimes hate geography!

Many schools nowadays agree that map-reading training should present a step-by-step development carefully suited to the learning abilities and interests of children at every step. Even at the first-grade level a beginning can be made. Children in the primary grades are eager and ready to learn how to use simple picture maps of their home and school neighborhoods, then of their community.

In the fourth grade boys and girls are mature enough to begin using symbolic maps. However, the transition from picture maps to symbolic maps should be made, not assumed. For example, a series of three maps covering the same area can be shown: The first can be an aerial photograph; the second, a map using picture symbols; and the third, a map using regular symbols—lines, dots, shading, etc.

Step by step in the middle grades, children can thus be prepared for the more complicated political and historical maps, until they are ready to interpret any map they see in the daily newspapers. Such gradual, meaningful training is essential if people are to develop enough skill in map-reading to use it with understanding throughout life.—*School Briefs*.

LUBRICATING OIL FOR EXTRA HEAVY PRESSURE

How to produce non-corrosive lubricating oils for use where pressures between the bearing surfaces rise to more than five tons to the square inch, is told by Carl F. Prutton of East Cleveland, Ohio, in U. S. patent 2,298,636 awarded him. The rights have been assigned to Lubri-Zol Corporation of Cleveland.

High pressure lubricants are usually corrosive, the inventor states, in fact depend on chemical action between the oil and metal to prevent seizure and scoring of the bearing surfaces. But he has found that certain halogen carbon compounds, particularly chlorinated compounds, inhibit this corrosive action without destroying the high pressure qualities of the lubricant. The action seems to be to form a protective film on the metal which prevents electrolytic action to which the corrosion is due.

His new "inhibitors" can be used to make new high pressure oils or to improve existing ones.

DIRECT CURRENT FOR YOUR LABORATORY

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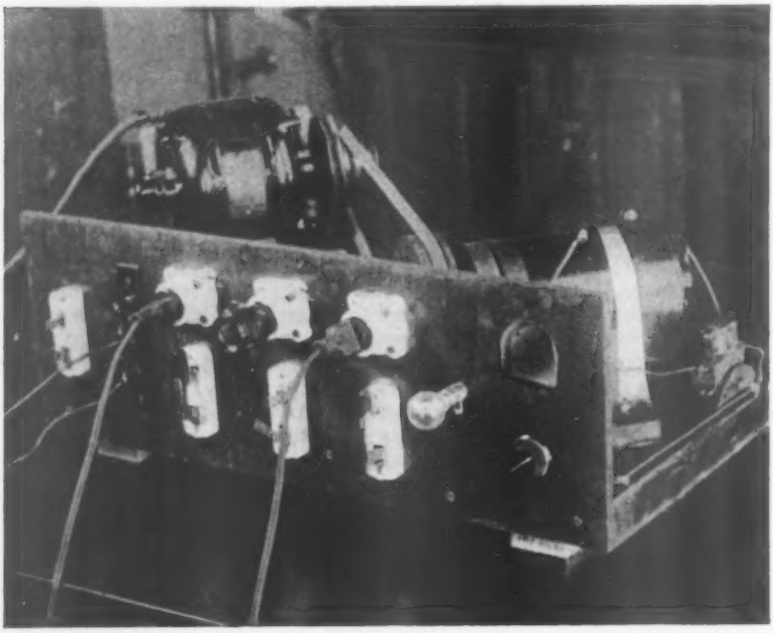
A source of direct current is a prime necessity in all high school laboratories. Without it many experiments and demonstrations are impossible. Dry cells are inconvenient, inefficient in the later stages of their life, and must be regularly replaced. Storage batteries are expensive, must be recharged, and must be cared for during the summer months.

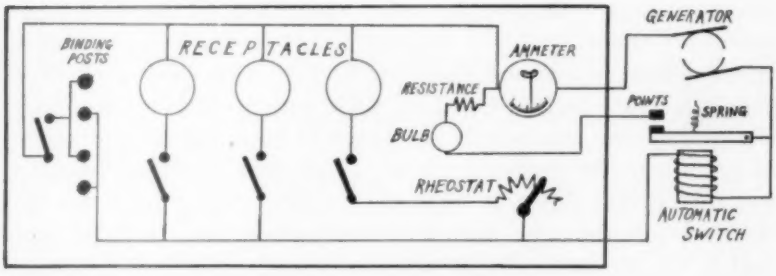


The motor-generator apparatus described here solved our problem satisfactorily. It was teacher-designed and constructed by students. The students who participated in the project acquired some practical experience in electricity and furnished our laboratory with a piece of permanent and sorely needed equipment. The generator was constructed from used parts, and the total cost was $4.55. (This does not include the price of the motor, since we had one on hand before beginning the project.)

Essentially, the outfit consists of a used automobile generator driven by a $\frac{1}{4}$ H. P. electric motor. The cut-out switch which

was attached to the generator was converted into an automatic switch. This switch short-circuits the generator and prevents it from burning out when the current is not being used while the generator is running. The other parts consist of an ammeter for measuring the current, switches, binding posts and receptacles for distributing the current, a rheostat which is connected in series with one of the receptacles, and an automobile headlight bulb which flashes on when the generator is running on the "short" circuit. The generator, ammeter, and cut-out were purchased from a junk yard for $3.75.

The motor and generator are mounted on a base 28″×18″ ×2″. A piece of plywood 28″×10″ is screwed to the front edge of this base to serve as a control panel on which the switches, receptacles, ammeter, etc. are mounted. The motor is provided with a step pulley and an adjustable base so that the speed of the generator can be regulated by using different steps on the pulley. The automatic switch is mounted on the baseboard near the generator.



On the left end of the control panel is a switch through which current is delivered to two pairs of binding posts mounted to the right of the switch. In the center of the panel are three switches, each of which delivers the current to the porcelain receptacle mounted directly above it. The third switch receives its current through a rheostat mounted in the lower right hand corner, so that one receptacle is provided with a controlled current. To the right of these switches and receptacles is the headlight bulb through which the "short" circuit runs. In the upper right hand corner is the ammeter, which is connected into both the main and "short" circuits.

A most important part of the apparatus is the cut-out switch. If the generator is running and is connected in a circuit it func-

tions normally. But if this circuit is broken, as it often will be during experiments, the generator will burn itself out unless it is grounded or "short circuited." The function of the revamped cut-out switch is to close the "short" circuit when the main circuit is opened, and to open the "short" circuit when the main circuit is again closed. This operation is performed automatically whenever the main circuit is made or broken.

It is a simple matter to convert the ordinary automobile cut-out switch into the automatic switch needed for this apparatus. As originally designed, the passage of a current through the coil of the cut-out magnetizes the iron core inside it; the core then attracts the armature above it so that the platinum piont on the end of the armature makes firm contact with a fixed platinum point mounted directly below it. When the current stops the core is no longer magnetized, the spring attached to the armature pulls it back to its original position, and the electrical contact is broken at the points. To make this apparatus function as the automatic switch for our generator set it was only necessary to move the fixed platinum point from its position below the armature to a corresponding point directly above it. Thus the operation of the switch is reversed; that is, the points remain closed when no current flows in the coil, and vice-versa. Our particular cut-out had the fixed point mounted on a long strip of metal so that it was only necessary to bend the strip in order to get it into the proper position. Each of the platinum points was then driven out of its mounting with a small punch and re-inserted from the opposite side. Some cut-outs are so constructed that it will be necessary to mount the fixed point in a separate strip of metal, which must then be securely soldered to the base of the original mounting.

A study of the wiring diagram will show how the switch controls the circuits. The armature and coil of the switch are connected in parallel. When no current is being used in the main circuit no current can flow through the coil in the switch. The spring then holds the point on the armature in contact with the fixed point; thus the current can flow in the "short" circuit, which includes the light bulb, a resistance, and the ammeter. Now if the cord from one of the receptacles or a pair of binding posts be connected to some appliance and the corresponding switch be closed, part of the current will flow through the coil and through the main circuit. As a result the armature will be attracted to the core, thus opening the "short" circuit and allow-

ing the entire output of the generator to flow in the main circuit. The instant this appliance is disconnected the core loses its magnetism and the spring pulls the armature away so that the points will be closed and allow the current to flow in the "short" circuit until the main circuit is again closed.

It is desirable to have a comparatively high resistance in the "short" circuit. If the resistance is too low the switch will not function properly when the main circuit is connected to a high resistance, since most of the current will then flow in the "short" circuit, and as a result the core of the switch will not be magnetized strongly enough to separate the points. The resistance consists of a coil of high resistance wire connected in series with the light bulb. The bulb is not necessary, but it is desirable as an indicator to show that the switch is operating correctly. The amount of resistance you will need depends upon the output of your generator, and this in turn depends upon the size of your motor and the speed of the generator. Both circuits should run through the ammeter to show the performance of the outfit at all times. Our unit is not provided with a voltmeter, but it might be a desirable addition.

The current is distributed to all parts of the laboratory by means of extension cords plugged into the receptacles. The positive and negative slots and prongs of the plugs are marked with red and green paint to indicate polarity. Each cord is tapped at intervals with Fahnestock binding posts, which are similarly marked for polarity. The binding posts on the control panel are convenient for demonstrations, making the use of the extension cords unnecessary for that purpose. Individual switches make the control of the binding posts and receptacles independent, and the rheostat on one receptacle is an added convenience.

Since we had a $\frac{1}{4}$ H. P. motor on hand we installed it in our generating set. While the set operates smoothly with this motor, the maximum output is only six amperes. A test with a 1 H. P. motor produced a current of 18 amperes. Until now 6 amperes has been sufficient for our needs, but we are considering the installation of a larger motor.

In addition to serving its function as a source of direct current, the generator set is useful in demonstrating a number of principles in electricity, such as the effect of resistances in parallel circuits, computing efficiency of the motor and generator, the third brush system of automobile generator control, the operation of relays (the automatic switch) and others. An inter-

esting demonstration can be presented by connecting a very high resistance to the receptacle served through the rheostat; by further increasing the resistance with the rheostat a point will be found at which the resistance is too high to allow the automatic switch to keep the "short" circuit open, and the indicating bulb will flash on. The switch will respond to very slight adjustments of the rheostat, the bulb flashing off and on as the resistance is decreased or increased.

SCIENCE CLUBS OF AMERICA

Science Clubs of America, the national organization of science groups in the nation's high schools, has begun a year of war service, with an accent upon preparing boys and girls with scientific ability for their most useful roles in war and peace.

This year any club in America's secondary schools, public, private or parochial, may affiliate with Science Clubs of America without payment of fees. Watson Davis, director, has announced this new arrangement on behalf of Science Service which administers Science Clubs of America as a part of its popularization of science activities.

Science clubs will be urged to devote their time and energies to giving their members the kind of experience that will help them engage in technical work for the armed forces, scientific research laboratories and industry, stressing expecially the kinds of service in which manpower is now lacking.

Each science club has an adult sponsor who is usually a science teacher in the high school. Clubs may have as many members as desired, the usual number being about twenty.

Upon affiliation with Science Clubs of America, the sponsor of the club receives assistance material, including information on how to organize and activate the club, suggestions on war services, lists of scientific educational material that may be obtained free or at low cost, lists of recommended books, a book containing the essays of the First Science Talent Search, and other material.

Affiliated clubs will also be brought into contact with scientific institutions, museums, and newspapers cooperating with Science Service in their locality.

The headquarters of Science Clubs of America is in the Science Service Building, 1719 N St., N.W., Washington, D. C., and information will be supplied on request.

MORE AND MORE SCHOOLS ARE WORRIED BY TEACHER SHORTAGES

Press reports from far-flung parts of the country identify new areas of teacher shortages. Among communities recently affected are: Hamilton County, Tennessee; Weld County, Colorado, where 7 one-teacher schools failed to open; Lancaster, Pennsylvania, where 13 high schools lack science and mathematics teachers; Dauphin County, Pennsylvania; "Northern New York" (according to a special dispatch to the *New York Times*); and Allegheny County, Pennsylvania, where 96 rural districts are affected.

NOTES FROM A MATHEMATICS CLASSROOM

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(*Continued from the November issue*)

30. Concurrent Lines in a Triangle. Many of the recent texts in geometry treat the four theorems about concurrent lines in the unit on loci. I prefer a different arrangement; my reasoning is:

About the ninth week of the semester we prove that the sum of the angles of a triangle is 180°. This theorem opens a rich field of new exercises and theorems. From it we prove the theorem about the congruence of right triangles having hypotenuse and arm respectively equal, etc. As a result of this theorem we can prove that if a point is equidistant from the sides of an angle the point is on the bisector of the angle, and a converse of this statement.

Just as soon as this theorem has been established I consider the concurrence of the angle bisectors of a triangle. This theorem is exceptionally good drill material for the theorems on which it depends because in one place in the proof the pupil must be careful to quote "If a point is on an angle bisector, etc." and in a later step in the proof the pupil must quote "If a point is equidistant from the sides, etc." Thus the pupil gets practice with both a theorem and a converse of it all within a few minutes.

With the theorem about a point on angle bisector it seems natural to group the theorem about a point on the perpendicular bisector of a segment, and its converse. Again, for drill on the latter theorem we can consider next the concurrence of the perpendicular bisectors of the sides of a triangle. In the proof of the concurrence the pupil again gets practice with a statement and a converse because at one place he must quote "If a point is on the perpendicular bisector, etc.," and in another place he must quote "If a point is equidistant, etc." Hence these two concurrence theorems make clear the notion of a theorem and a converse and is a good test of the pupil's ability to distinguish the two relations.

The concurrence of altitudes is of minor importance. It is a good exercise but hardly deserves to be called a theorem inasmuch as the pupil will have no occasion to use it in solving other exercises. The concurrence of the medians is more important and can be used to introduce the notion of center of gravity

either here or in Book IV. It can be proved at the end of Book I because it is good material for review work.

With this arrangement none of the concurrence theorems would be proved under the work on loci although they could well be gathered and summarized at that point.

31. The Associative Law of Multiplication. When the class uses the formula for the area of a triangle, $A=\frac{1}{2}bh$, some pupil invariably asks, "Does that mean half of b or half of bh?" When that question arises, we stop to discuss, "How much is $2\times3\times4$?" in order to point out that we may take 2 times 3, or 2 times 4, but not 2 times both 3 and 4. The pupil thinks that if 3 and 4 are first multiplied, and the product then multiplied by 2, we are in fact doubling both 3 and 4 because "we are doubling 12, and isn't 12 the result of both the 3 and 4?" A lecture on the associative law of multiplication is hardly necessary but a ten minute discussion will save time later.

Several times during the year I have occasion to ask, "Do you remember what we learned about $2\times3\times4$?" For example, when solving $2x+5y=7$, $3x+8y=4$ by the substitution method we are led to: $2x+5(4-3x)/8=7$.

Using 8 as a multiplier, some pupil will next write

$$16x+40(4-3x)=56.$$

But we really have $8\times\frac{5}{8}\times(4-3x)$ and may now take *either* 8 times $\frac{5}{8}$ *or* 8 times $(4-3x)$. This is a better explanation than merely saying that the 8's cancel.

The same question arises when we need to explain why the sign of a factored polynomial is changed by changing the signs in a single factor. And a change of $3(x+y)^2$ to $(3x+3y)^2$ is a violation of the same law. Instead of hanging a picture of Euclid or Archimedes on the walls of my classroom I would like a large placard reading "How much is $2\times3\times4$?"

32. Literal Equations and General Problems. All algebra texts contain some work on equations like $ax=b$ and $a+x=b$ as a part of, or as an introduction to the work on solving formulas like $A=\frac{1}{2}bh$ for b or for h. In many texts the simpler literal equations are treated in scattered places as optional work under the similar non-literal equations. The work on literal equations deserves more respect, and I suggest a treatment like the following:

Begin by discussing what is meant by generalizing a problem. A good one to start with is: A can do a job in 10 days, and B

can do the same job in 8 days; how many days are needed if both men work on the job? (This should be solved by elementary arithmetic without any algebra.)

Next, suppose that we have a great many problems all of this kind; it would then be convenient to have a formula for the answer. Hence we would like to solve the problem: If A can do a job in a days, and B can do the same job in b days, how many days are needed if both men work on that job?

Here we stop for ten minutes to generalize problem 16 on page 123, problem 17 on page 234, and half a dozen others chosen any place in our text. The pupil merely reads a, b, c, etc., wherever the problem mentions a specific number.

We have thus motivated the work on literal equations, and now proceed to their solution. Two pupils are sent to the board. One of them is asked to write *any* equation from *any* place in his textbook, and even if he chooses one like

$$60x+40(80-x)=4200$$

we accept it without complaining. The second pupil generalizes this equation by writing

$$ax+b(c-x)=d.$$

The first pupil next writes: $60x+3200-40x=4200$,
and the second pupil writes: $ax+bc-bx=d$.

The first pupil writes: $60x-40x=4200-3200$,
and the second pupil writes $ax-bx=d-bc$.

The first pupil writes $20x=1600$ and then it is best for both pupils to be seated while the class discusses:

"How many x's are there in $ax-bx$, or, what is the sum of ax and $-bx$?"

A good answer is: There are $a-b$ x's, that is, the left member is $(a-b)x$ or $(a-b)$ times x.

The two pupils can now return to the board. The first pupil writes $x=\dfrac{1600}{20}$, and the second writes $x=\dfrac{d-bc}{a-b}$. The pupils think this is an interesting game. The poorest pupil in the class is thrilled to find that he can solve any literal equation if he can have another pupil alongside him to solve step by step the corresponding non-literal equation.

The class has learned how to generalize a problem, why it is useful to generalize a problem, and how to solve a general equa-

tion. And, as a pupil once said, "I finally see why a is a *number* and not a letter of the alphabet."

To my mind this work is the culmination of the work in first year algebra; it is the *raison d'être* for algebra. Certainly the scattered haphazard treatment now given to literal equations is a neglect of an important topic. If I wished to find out what a pupil knows about algebra and was limited to proposing a single problem, I would give him any one of the so-called story problems, ask him to generalize it, to solve the generalization, and to check his answer. The last step would test his ability to handle fractions.

33. Changing the Subject of a Formula. Instead of giving to general problems the respect that they deserve, most of the work on literal equations seems to be done merely to introduce the solving of a formula for a particular variable. This brings up the question: How useful or important is it to change the subject of a formula? If $A=\frac{1}{2}h(a+b)$, and also $A=60$, $h=5$, and $a=8$, it is not necessary to solve the equation first for b. I need merely substitute the data in the formula and regard the result as an equation in b.

Changing the subject of a formula is useful if:

(1) I have a second formula in which I wish to substitute the solution from the first formula. The most that we do along that line is to allow a pupil to solve a general problem by using two equations in two unknowns; and then one of the equations is usually a simple one like $x+y=s$.

(2) I wish to study the dependence of b on the other variables in the formula. Thus, from the formula

$$b=\frac{2A-ah}{h}$$

I can more readily see that b decreases if A and h are constant while a increases. The value of this type of work is well presented by H. C. Christofferson in an article in the *Mathematics Teacher*, Dec. 1941, page 346. I have found that his example is a bit difficult for ninth-graders but teachers should keep the idea in mind and search for other similar examples.

"You of the class of 1946 will be called into active service long before the completion of your college course."—*President James B. Conant, Harvard University, who, in addressing the freshman class, urged them to make the best of the few months in college.*

THE SUBJECT MATTER OF GENERAL SCIENCE

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The following article was made possible by a grant from the Joint Research Committee of Claremont Colleges, California. The tabulations were made by the junior author, while the article was written by the senior author, who takes all responsibility for any errors of interpretation that may be found in the pages that follow.

A very comprehensive questionnaire, based in part on a questionnaire put out by the senior writer in 1930, was used to obtain the data that follow. This new questionnaire was sent out to some 2200 representative junior and senior high schools in all parts of the country. Replies were received from schools in every state in the Union, a total of 655 schools responding. These schools were segregated by areas which had been arbitrarily used in a series of questionnaires sent out by the senior author in his attempts to follow the evolution of secondary school science sequence in this country. Articles[1,2,3,4] based on these questionnaires are listed in the footnotes below.

The states responding to these questionaires were listed under the following headings: New England, Middle, Southern, North Central, Rocky Mountain, and Pacific. Distribution was as follows:

New England States 50, Connecticut sending 12 replies, Maine 10, Massachusetts 20, New Hampshire 4, Rhode Island 2, Vermont 2.

Middle States 131, Delware sending 3 replies, District of Columbia 2, Maryland 3, New Jersey 17, New York 67, Pennsylvania 39.

Southern States 138, Alabama sending 6 replies, Arkansas 3, Florida 10, Georgia 5, Kentucky 11, Louisiana 5, Mississippi 7, Oklahoma 33, North Carolina 11, South Carolina 4, Tennessee 2, Texas 29, Virginia 8, West Virginia 4.

North Central States 175, Illinois sending 25 replies, Indiana

[1] Hunter, George W. "The Methods, Content and Purpose of the Biological Science in the United States," SCHOOL SCIENCE AND MATHEMATICS 10: 1–10, 103–111; January, February, 1910.

[2] Hunter, George W. "The Place of Science in the Secondary School." *School Review* 33: 370–381, 453–466; May, June, 1925.

[3] Hunter, George W. "The Sequence of Science in the Junior-Senior High School." *Science Education* 16: 103–115; December, 1931.

[4] Hunter, George W. "Science Sequence in the Junior and Senior High Schools." SCHOOL SCIENCE AND MATHEMATICS 33: 214–223; February, 1933.

24, Iowa 28, Michigan 32, Minnesota 9, Missouri 19, Ohio 21, Wisconsin 14.

Rocky Mountain States 88, Arizona sending 5 replies, Colorado 14, Idaho 4, Kansas 17, Montana 10, Nebraska 15, Nevada 2, New Mexico 6, North Dakota 2, South Dakota 9, Utah 3, Wyoming 2.

Pacific States 76, with California sending 52 replies, Oregon 8, Washington 16.

Total for the United States 655.

It is evident from these figures that a fairly representative picture of the country as a whole is given. It was found in a study of the answers by respondents in different areas that this arbitrary grouping of states showed rather definite tendencies toward coordination of thinking by teachers in the different areas. For example, the New England area showed quite a different distribution of subject matter than did other parts of the country, while the Southern area had quite a different distribution of general science subject matter from the North Central area which is adjacent to it on the north.

Those of us who have studied the evolution of general science in this country remember that the subject came into existence partly as a protest against the pure science of the period following the report of the Committee of Ten; partly as an interesting introduction to other sciences which would naturally follow in the later years of high school, and partly as a means of interesting young people in the interpretation of their science environment. Then with the coming of the junior high school, general science spread out and moved downward into the seventh and eighth grades as well as keeping its place in the ninth grade in the four year high school. Series of excellent texts came into existence, each of which had its own philosophy with good and sufficient reasons for the inclusion of and sequence of certain subject matter. The evolution of these texts from those of early days shows today very different philosophies and points of view; while from the standpoint of construction and format the later series of texts are outstanding. This country has reason to be proud of its introductory science texts, chiefly because of their many motivating devices and practical applications for everyday living. It is no wonder that today general science is strongly entrenched as a junior high school core subject and as an introductory science in the ninth grade of the four year high school.

But, if textbooks and courses of study are any criteria, there is no unanimity of belief on the part of educators as to what should be the content or sequence of subject matter of general science.

There has been in the past considerable work done on the content of general science based on the content of texts. Such are the studies of Webb,[5] Weckel,[6] Klopp,[7] Downing,[8] Davis,[9] Wyman,[10] Heiss,[11] Rodean,[12] and others. Their papers in general showed the changing content of general science as evidenced in texts of the period. While there was an indefinite pattern at first made up of segments of the various sciences taught in high school and college, later there began to emerge a pattern that showed more social and more health application in this field.

Several recent studies have been made on the content of general science courses as based on a study of texts. Simmons

MAJOR TOPICS—PER CENT DEVOTED TO EACH

	1911–16		1917–23		1924–28		1929–34	
	Per cent	Place	Per cent	Place	Per cent	Place	Per cent	Place
Air	8.4	5	4.9	9	4.6	9	5.4	9
Animal Life	4.1	11	1.8	12	3.8	13	3.1	12
Electricity	7.1	7	6.3	6	4.9	8	6.2	7
Energy	1.2	16	1.3	14	0.9	15	2.8	13
Forces of Nature	3.3	14	1.4	13	0.8	16	0.8	16
Health	9.5	3	21.7	1	18.8	1	26.1	1
Heat	9.1	4	12.9	2	11.5	2	7.6	4
Light	7.7	6	5.7	7	7.3	5	3.6	11
Machines	5.1	10	12.5	3	10.4	3	7.7	3
Matter	2.2	15	2.8	10	4.3	12	1.8	15
Planets	3.9	12	1.8	12	4.5	10	6.7	5
Plant Life	5.7	8	7.1	5	9.6	4	5.5	8
Soils	11.9	1	2.4	11	5.4	7	4.7	10
Sound	3.6	13	1.0	15	4.4	11	2.0	14
Water	11.7	2	10.8	4	5.5	6	9.4	2
Weather	5.5	9	5.6	8	3.3	14	6.6	6

[5] Webb, H. A. *General Science Instruction in the Grades*, "A Quantitative Analysis of General Science Texts." Contributions to Education No. 4, Part I, George Peabody College for Teachers, 1921.

[6] Weckel, Ada L. "Are Any Principles of Organization of General Science Evidenced by the Present Textbooks on the Subject?" SCHOOL SCIENCE AND MATHEMATICS, January, 1922.

[7] Klopp, W. T. "A Study of the Offerings of General Science Texts." *General Science Quarterly*, May, 1927.

[8] Downing, E. R. "An Analysis of Textbooks in General Science." *General Science Quarterly*, May, 1928.

[9] Davis, I. C. "Analysis of the Subject Matter in the Eight Most Widely Used Textbooks in General Science," SCHOOL SCIENCE AND MATHEMATICS, June, 1931 .

[10] Wyman, W. T. "General Science Textbook Making." *Science Education*, October, 1931.

[11] Heiss, E. D. *An Investigation of Content and Mastery of High School General Science Courses*. E. D. Heiss, Stroudsburg, Pennsylvania, 1932.

[12] Rodean, W. A. "Overlapping in Content in Textbooks in General Science and Biology." *School Review*, March, 1932.

has had published several reports all based on a master's thesis given at the Montclair (New Jersey) State Teachers College. In his earliest paper[13] he took sixteen major topics and traced the changes that were found in the page allotment of certain texts which appeared between the years 1911 and 1934. The changes in emphasis are shown in the above table.

Objection to these findings might be made on the basis of subjectivity in findings as well as in the limited choice of texts, there being only four texts used for the 1911–16 period, four for the 1917–23 period, four for the 1924–28 period, and six for the 1929–34 period. In the latter period three of the texts were in a general science series for the junior high school (seventh, eighth, and ninth years). But on the whole these figures probably give a fair picture of the changes in emphasis that are taking place.

Another recent paper, that of Pettit,[14] deals with thirteen books, five written for the seventh grade, four for the eighth grade, and four for the ninth grade. The series of texts used were all published from 1934 to 1938, and so give a picture of a later development than shown by the paper previously quoted. Different techniques were used by the two writers, but certain trends are seen. One is that no great uniformity in use of topics was found in the texts at the various levels. For example, at the seventh grade level of the 155 topics used, only 11 per cent appeared in the majority of the texts. Seventh grade texts were predominantly biological in their texts, but of concepts presented biological topics still held first place in the eighth and ninth grade texts. Health topics were high at all three grade levels. The following table shows the total number of concepts in the different subject matter fields given at the different grade levels.

	Seventh Grade	Eighth Grade	Ninth Grade
Astronomy	33	99	14
Biology	587	520	520
Chemistry	349	310	310
Geology	132	73	73
Health	350	350	350
Physics	261	215	215

It is obvious that biological and health subject matter have come to play an important role in general science texts at the junior high school level.

[13] Simmons, M. P. "Changing Conceptions of Major Topics in General Science Textbooks (1911–1934)," *Journal of Educational Research*, November, 1937.

[14] Pettit, D. D. "The Content of Junior High Science." SCHOOL SCIENCE AND MATHEMATICS, October and November, 1940.

A still more recent paper by Graham[15] gives another picture based on eight widely used ninth grade science texts published between the years 1930 and 1938. In this analysis the following total percentages are found for the eight books studied.

Living things, 11.4 per cent; Health 7.9; Crust of the Earth, 7.9; Machines, 6.2; Foods, 5.9; Electricity and Magnetism, 5.8; Transportation, 5.7; Heat, 5.6; Light, 5.6; Astronomy, 5.5; Communication, 5.5; Water, 5.3; Air, 4.6; Weather and Climate, 4.1; Matter and Energy, 3.7; Environment, 3.1; Fire and its production, 2.4; Clothing 2.0; Sound, 2.0.

Graham sums up the analysis by stating that authors are evidently coming more in agreement over the units to be treated, but that they show "a slight tendency to emphasize the chief science interests of the authors."

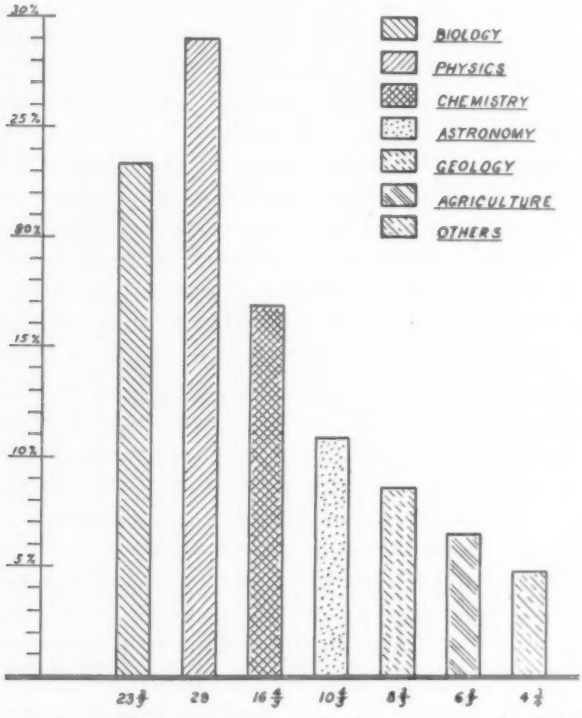
An investigation of present day subject matter would probably show a still different distribution of topics. Moreover material based on the subject matter of texts rarely shows the true picture. Those who teach the subject are more likely to give us a closer picture of what is really happening. It therefore seemed fitting to attempt to find out just what subject matter was included in general science as given in the schools of this country at the present time. So the following question was included in the questionnaire referred to in the preceding paragraphs: "Check by means of approximate percentages the proportionate amount your general science course draws from the following: Biology . . . , Physics . . . , Chemistry . . . , Geology . . . , Astronomy . . . , Agriculture . . . , and others . . . ." While all the respondents did not answer this question, the response was on the whole satisfactory, and the answers were almost uniformly usable. The following table shows the responses tabulated by areas. Physical science is evidently still the backbone

Areas	Percentages of Biology	Chemistry	Physics	Geology	Astronomy	Agriculture	Others
New England	15.52	23.52	39.40	6.36	13.71	2.09	4.98
Middle States	27.06	16.60	30.49	7.91	12.88	4.95	2.78
Southern States	25.44	16.66	27.32	7.73	8.30	7.86	4.94
North Central	24.53	16.55	25.95	8.64	9.21	7.43	4.25
Rocky Mountain	22.51	16.22	26.46	8.65	9.46	10.02	6.50
Western States	25.74	13.37	24.40	11.13	10.66	6.27	5.00
United States	23.47	16.82	29.00	8.40	10.70	6.43	4.74

[15] Graham, C. G. "Some Data Pertinent to Textbooks of General Science." *Science Education*, January and February, 1941.

of the general science course, both at the junior and senior high school levels, with biological materials taking second place. Chemistry comes third, astronomy fourth, geology fifth, agriculture sixth, and "others" in seventh place.

As can be seen from the table above there are considerable differences in the makeup in subject matter of the general science course in the various areas of the country. For example, while physics forms the core of the general science courses in



Percentages of subject matter in general science courses in 655 secondary schools in the United States.

New England (nearly 40 per cent being physical science), in the Western area biology has first place with 25.74 per cent of the subject matter holdings. In all of the areas except New England biology holds a high place, being a close second to physics in all the other areas. Over 52 per cent of all subject matter of general science is placed in these two catagories.

As might be expected conservative New England also shows a higher percentage of chemistry in the makeup of the general

science course than in any other area of the country. While the mean for the country is around 16 per cent, New England has 25.52 per cent. The Western area has the lowest percentage of chemistry with only 13.37 per cent.

The amount of geology taught in the various areas differs slightly. The Western and Rocky Mountain states give the most geology, as one would expect from the environment. But New England teaches the least amount of geology. Does this mean that most of the general science is given in the cities of New England? Certainly environmental teaching in most districts would naturally place emphasis on the geology of this interesting part of the country. There is no clue to our answer in the data we have.

New England and the Middle States emphasize astronomy more than the other areas while the Southern States teach the least astronomy.

As we would expect, agriculture is most emphasized in those areas that are predominantly rural. The Rocky Mountain area, which contains the great plains, is far above the others, with the Southern area and the North Central states in the order named.

Under the heading "Others", we find some interesting and rather suggestive topics. Health and hygiene are mentioned most frequently and in not a few schools they play a very important part in the general science course. In the Southern states especially some general science courses, particularly at the lower grade levels, are called "health science." If one reads between the statistical lines and looks at the courses of study and texts he sees why this emphasis is noted. One school in the Rocky Mountain area gives over 70 per cent of the subject matter as hygiene while another school in the New England area devotes over 50 per cent of its holdings to health teaching. Several schools in Illinois and the Central West give from 20 to 30 per cent of their subject matter as "health" or "hygiene." Among the other topics given under the heading "Others" we find the following: meteorology; weather; "nature"; conservation; safety; drugs and narcotics; foods; physical geography; photography; electricity; psychology; history of science, and scientific method. One school in Colorado devotes over 50 per cent of its subject matter to mathematics. Health and hygiene is mentioned most frequently, with meteorology second and most of the other topics scattering with from one to three mentions.

Teachers of the physical sciences have been rather skeptical as to the values of general science as it concerns the student's later contacts with chemistry and physics. So the following question was asked of the respondents: "Do your advanced courses gain anything from the general science course as now given?" The answers were checked in a table which followed the question. The results of the answers to this question are tabulated below.

Subject	Considerable	Little	None
Biology	242	161	11
Chemistry	116	251	29
Physics	198	171	21
Science Survey	65	38	15

It will be noted that almost 60 per cent of the biology teachers feel that general science is of considerable value to those who have first taken this subject before the subject of biology and almost 50 per cent of the physics teachers state that general science is of considerable value for those who later take physics in high school. On the other hand, less than 30 per cent of the chemistry teachers responding say that the general science course is of considerable value to their students. Possibly this may be due to the lack of emphasis placed on chemistry in the general science courses (the average emphasis is 16.82 per cent as against 23.47 per cent for biology and 29 per cent for physics); or perhaps the findings of Dr. H. W. Webb (given in one of his early papers) to the effect that chemistry is not within the comprehension of the junior high school pupil may be a factor. At any rate the judgment of teachers of chemistry is here given for what it is worth.

Figures on the "science survey" are interesting because of the implication that a fairly large number of schools responding must give such a course. While the totals of the number of schools differ (those giving biology numbering 414; those giving chemistry 396, and those giving physics 390), the average number is 400. The schools responding for the science survey total 118. This would make more than one out every four schools responding give a science survey course. These figures bear out those of Watson[16,17] as given in recent papers. He reported in 1940 the existence of 578 fused science courses in schools in all

[16] Watson, D. R., "Survey Courses in Science," *Science Education*, January, 1940.

[17] Watson, D. R. "The Fused Physical Science Course," *California Journal of Secondary Education*, May, 1940.

parts of the United States, with 328 such courses in the California schools. Today the number would be much larger.

Although we have no very accurate figures on general science enrollment in this country, it is evident from the statistics quoted by the senior writer[18] in an earlier paper that general science has a much larger enrollment than any of the other sciences. In the senior high school figures were obtained which showed that in 329 schools in the United states, having a total enrollment of 292,049, the general science enrollment was 99,784, or 25.40 per cent. This would be greatly increased if the figures from the junior high schools were counted. It is evident from these figures that general science has come to stay.

[18] Hunter, G. W., and Spore, Leroy. "Science Sequence and Enrollments in the Secondary Schools of the United States," *Science Education*, December, 1941, and February, 1942.

DEMON STAR MAY BE QUADRUPLETS INSTEAD OF JUST TRIPLETS

Amateur astronomers and constellation students all know the star Algol, in the constellation of Perseus, as one which regularly undergoes a change in its light. At intervals of 2¾ days, it loses about a magnitude in its brightness, taking five hours to reach minimum brightness and five hours to come back to normal brightness.

Ever since Goodricke, a youth of 19, deaf and dumb, proposed in 1783, that the Demon Star (El Ghoul to the Arabs) was double, and that the light fluctuations resulted from eclipses of one star by the other, Algol has been carefully watched by astronomers. There is no doubt that Goodricke was right, and since his day astronomers have decided there is a third star—Algol C—which is invisible with present telescopes, but makes its presence known by its gravitational effect on the other two stars.

Now, Dr. Zdenek Kopal, of Harvard Observatory, proposes that there may be a fourth component of the system, and that Algol, one star to the eye and the telescope, is really quadruplets. He bases his proposal on slight irregularities in the times of Algol's minimum brightnesses, and evidence that the principal stars are in rapid rotation, but not on axes which are perpendicular to the plane in which they revolve—this is contrary to the usual expectation.

If a fourth Algol does exist—Algol D, if you wish—Dr. Kopal ventures that it will be no ordinary star, but of the class called subdwarf, of which only a few examples are known. These are stars of high mass and low luminosity, but not as dense and faint as the "white dwarfs" of which the companion of Sirius is the best example.

"The only place where your organization (The American Federation of Labor) will get a fair hearing is in the classrooms of America."—*John M. Fewkes, American Federation of Teachers, who told the 1942 AFL Convention that labor does not get a "fair deal in the press."*

CHEMISTRY IN THE NEWS*

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Inasmuch as the newspaper is so generally read, it is of significance to those interested in chemistry to learn what type of chemical information is featured in the news. Studies which have been made show that many non-specialized magazines for the general reader carry a good deal of material on chemistry. Many products are heavily advertised almost everywhere, with claims that purport to be supported by the findings of chemistry. The chemistry found in the news itself has been comparatively neglected as a subject for analysis.

The New York *Times* was the newspaper analyzed in this study. It was originally planned to study other newspapers as well, but the magnitude of the undertaking would have been prohibitive. The New York *Times* was analyzed for its science content during the complete years of 1930, 1933, 1936, and 1939. Each issue was carefully scanned, including the whole of the Sunday edition, with the omission, however, of advertisements, daily weather maps, weather forecasts, and crop reports. The completed analysis included forty-eight months, or 1,461 newspaper issues comprising not less than about 75,000 pages.

As each scientific reference was found, it was measured in column-inches and recorded on an ordinary index card. It was arbitrarily decided not to include any reference if it were less than one-half column-inch in length. Regardless of the title or major emphasis of any newspaper article, any science it might contain was measured. It was attempted to include only the science content, hence material of a political and circumstantial nature was omitted, even though it might be found in an article bearing a scientific title. For example, an article on photography might include a good deal of information on "composition," selection of artistic subjects and the like, in addition to the technical information relating directly to the photographic process itself. Only the latter would be measured. It was sought also to make the analysis detailed, sometimes separating a single reference or article into several topics, depending upon the nature of the content. As an instance of this, a newspaper report

* From dissertation for degree of Doctor of Education entitled "An Analysis of the Science Content of the New York *Times* and of Selected General Science Textbooks." Temple University, Philadelphia, 1942.

on a medical subject might include a description of a disease, and information on synthetic drugs and vaccines. The report would not be recorded as a unit, but divided among the several topics indicated.

In order to check the reliability of the study, three months chosen at random were analyzed completely and independently for a second time. The deviations in amount of space devoted to the various topics between the first and second analyses averaged three and seven-tenths per cent. It seems reasonable, therefore, to assume the study to be reliable within the limits indicated by this check.

The completed analysis consisted of 185 topics devoted to Science, comprising a total of 52,238 column-inches of space. The topics were classified into 14 major-topics. The per cent of the total space devoted to each of the major-topics is shown in Table 1.

TABLE I. PER CENT OF TOTAL NEWSPAPER SCIENCE VOLUME DEVOTED TO EACH MAJOR-TOPIC DURING THE COMBINED YEARS OF 1930, 1933, 1936, AND 1939 IN NEW YORK *Times*

Major-Topic	Per Cent
1. Health and Medicine	20.1
2. Chemistry	9.5
3. Communication and Transportation	8.7
4. Animal Life	8.1
5. Man and Behavior	7.4
6. Gardening and Agriculture	6.9
7. Earth Science	6.5
8. Weather and Forecasting	6.5
9. Atomic Investigation, Theoretical Physics	5.9
10. Astronomy	5.4
11. Forms of Energy, Applications	4.9
12. Conservation	4.2
13. Plant Life	3.8
14. Mechanics	2.1
TOTAL PER CENT	100.0

It will be seen that the topic Health and Medicine makes up approximately one-fifth of all the space devoted to science in the newspaper, with chemistry in second place, having nearly one-tenth of the total devoted to it. An examination of the per cents for each of the four years analyzed shows, however, that chemistry increased rapidly in importance, whereas Health and Medicine remained relatively constant. In 1930, only 7.4 per cent of the science in the newspaper was devoted to chemistry. In

1933, this increased to 8.1 per cent, and in 1936, to 8.2 per cent. In 1939, however, the per cent nearly doubled, jumping to 16.0. These figures would seem to indicate that chemistry is coming increasingly to the attention of the public in the newspaper.

The total volumes in column-inches for the combined years of 1930, 1933, 1936, and 1939 for each of the thirty-one sub-topics under Chemistry are shown in Table II. In setting up the sub-topics, it was sought to make them reflect as much as possible the fields receiving the greatest newspaper emphasis, even though this did not permit an entirely systematic organization. For example, Carbon Monoxide and Oxygen should logically have come under gases. The separate treatment, however, should be more informative. Of a total of 52,238 column-inches of space devoted to all the branches of science in the newspaper, 4,969 column-inches were devoted to chemistry. It will be seen that the sub-topics are rather artificially grouped under the heads of Principles of Chemistry, and Applied Chemistry.

Most of the chemistry in the New York *Times* was applied, and was presented usually with the assumption that the reader possessed a broad background of chemistry. Under the heading Principles of Chemistry, one of the most frequently mentioned topics was explosions. Since most of the explosions described resulted accidentally from ordinary combustible material, it would seem that the public can profit from instruction regarding the nature of, and conditions producing explosions. Organic chemistry increased from 42 column-inches of space in 1930, to 132 column-inches in 1939.

Under Applied Chemistry, the topics receiving the greatest newspaper attention were fuels, nutrients, photography, and vitamins. As might be expected, the attention given in the newspaper to vitamins progressively increased, rising from 55 column-inches in 1930, to 129 column-inches in 1939. The gain in photography was much more marked, the space increasing from 19 column-inches in 1930, to 260 column-inches in 1939. Another topic showing a progressive increase in newspaper importance between 1930 and 1939 was plastics. Under nutrients, most space was devoted to proteins, but food testing and preservatives were also important.

Two topics, which were placed under the major-topic Atomic Investigation, Theoretical Physics, should be mentioned. They are Atoms, Atomic Investigation, and molecules, which covered

TABLE II. SUB-TOPICS WITH NEWSPAPER VOLUMES IN COLUMN-INCHES UNDER CHEMISTRY

Sub-Topic	Total Volume
Principles of Chemistry	
1. Acids, Bases, Salts	95
2. Compounds, Chemical Reactions	203
3. Elements and Isotopes	225
4. Gases (especially Helium and Hydrogen)	183
5. Carbon Monoxide, Carbon Dioxide	116
6. Oxygen and Ozone	78
7. Oxidation, Combustion	85
8. Explosions	258
9. Halogens	37
10. Metals, excepting Iron	135
11. Nitrogen and Nitrates	57
12. Organic Chemistry	294
13. Solutions, Colloids	30
TOTAL	1,796
Applied Chemistry	
1. Cellulose and Lignin	67
2. Concrete, Building Materials	101
3. Explosives	110
4. Fuels	260
5. Glass	60
6. Iron and Steel	106
7. Metallurgy, Alloys	149
8. Nutrients (especially proteins)	457
9. Vitamins	389
10. Enzymes	105
11. Food and Drug Laws	182
12. Photo-Electric Phenomena	189
13. Photography	413
14. Plastics	150
15. Poison Gases and Masks	130
16. Synthetic Rubber	77
17. Textiles	66
18. Synthetic Textiles	162
TOTAL	3,173
COMBINED TOTAL	4,969

a total of 1,386 column-inches, and Radium and Radioactivity, a topic covering 200 column-inches.

The chemistry found in the New York *Times* is present in significant amount, and is to a large degree, technical. The chemistry in the news generally features applications of chemistry, and

assumes a knowledge of fundamental principles on the part of the reader.

One of the aims of instruction in chemistry should be to provide the average person with a background which will enable him to read the chemistry in the news with some degree of understanding. Moreover, the teacher who notes the appearance of new developments in chemistry appearing in the newspapers is in a position to make his instruction more vital and meaningful.

THE SOLUTION OF THE QUADRATIC EQUATION

ADRIAN STRUYK

Clifton High School, Clifton, New Jersey

The following method of justifying the factoring and the formula procedures for solving quadratic equations may be of interest to those who find it profitable, on occasion, to depart from the customary treatment.

The basic and unifying principle is this theorem: The numbers r and s are the roots of the equation

$$ax^2+bx+c=0 \quad (a\neq 0) \tag{1}$$

if

$$r+s=-b/a, \qquad rs=c/a. \tag{2}$$

Proof: According to (2), we may write $-a(r+s)$ for b and ars for c in (1). Then, after dividing by a, we get

$$x^2-(r+s)x+rs=0. \tag{3}$$

The first member of (3) has the value zero if x is replaced by r or by s. Hence the theorem.

It is now easy to show that, if ax^2+bx+c is factorable, the factors furnish the quantities necessary for forming the roots of (1).

We shall be able to write

$$ax^2+bx+c=(mx+n)(px+q)$$

only if

$$a=mp, \qquad b=np+mq, \qquad c=nq.$$

Then

$$-b/a = -(np+mq)/mp = (-n/m)+(-q/p),$$

and

$$c/a = nq/mp = (-n/m)(-q/p).$$

By the theorem, therefore, the roots are $-n/m$ and $-q/p$. They are obviously involved in the factors.

The expression ax^2+bx+c is usually not factorable. Solution of (1) can then be effected by the formula. This we proceed to develop.

Consider the identities

$$r = \tfrac{1}{2}(r+s)+\tfrac{1}{2}(r-s), \qquad s = \tfrac{1}{2}(s+r)+\tfrac{1}{2}(s-r). \tag{4}$$

The numbers $r-s$ and $s-r$ are the two square roots of $r^2-2rs+s^2$. This trinomial is, moreover, a function of the sum and the product of r and s, as expressed in the identity

$$r^2-2rs+s^2 = (r+s)^2-4rs.$$

Both identities (4) are, therefore, contained in

$$x = \tfrac{1}{2}(r+s \pm \sqrt{(r+s)^2-4rs}). \tag{5}$$

By using (2) in (5), and simplifying, we obtain

$$x = (-b \pm \sqrt{b^2-4ac})/2a.$$

QUININE WANTED FOR WAR USE

Quinine, now worth several times its weight in gold to American forces fighting in malaria-ridden tropics, is lying idle in little hoards at universities and other institutions all over the country, Dr. Harry N. Holmes, president of the American Chemical Society, is convinced. He has issued an appeal to all laboratory heads having unused stocks of the invaluable drug to turn them in, as an aid to their country at war.

In addition to its unique use in combating malaria, quinine is used by organic chemists in preparing certain compounds of technical interest but no medicinal value. On a search for quinine kept for this purpose, Dr. Holmes asked his fellow chemists, during a recent lecture tour, to look at their stock shelves and see what they had on hand. He found a pound at Yale, at the University of Vermont half a pound and in Boston a pound or more.

He has therefore issued a general appeal to chemists who have quinine to write him, so that he can forward their letters to the proper medical authorities. He does not want to have the quinine sent to him directly, but only information as to its whereabouts, and the willingness of present owners to sell at current prices.

Dr. Holmes' address is Oberlin College, Oberlin, Ohio.

THE USES OF MATHEMATICS BY THE OTHER SCIENCES

HENRY W. SYER
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The following talk was part of a mathematics assembly presented to the school by members of the mathematics department. Naturally, in the oral presentation many additional explanatory remarks were made which will suggest themselves to the reader. Consider this only as an outline which may suggest a similar talk to others interested in the connections between mathematics and science, and visualize this explanation as part of a lively discussion with illustrations and demonstrations rather than a cut and dried speech.

The key note of the program was "action" and experiments were constantly being performed by members of the department on the stage as the explanation was related. The need for special apparatus is indicated by numbers thus [5]. The apparatus is then listed at the end.

Mathematics makes two chief contributions to the other sciences: by developing methods and by developing tools. Mathematical methods of thinking are the molds in which the other sciences are formed; mathematical tools are the instruments which give science its precision.

The first aspect of the mathematical method is the need which science now recognizes to assume unproved statements as the foundation for each branch of science; much as geometry is careful to state its unproved statements or postulates before proceeding to proofs. I shall cite just three examples of this: (1) The assumption that all matter is composed of molecules that are in constant motion. This is fundamental in all sciences especially chemistry and physics. (2) The assumption that energy can not be destroyed, but only transformed. This fact is often quoted in physics. (3) The assumption that molecules in benzene arrange themselves in a ring-like shape which can be moved about from compound to compound with great stability.

To illustrate these three assumptions I shall open a bottle of ammonia in the middle of the hall [1] and you will gradually be aware of its odor as the moving molecules carry it through the air. Secondly, I have here an electrical transformer which reads 110 volts and 5 amperes on one side and 10 volts and 55

amperes on the other. [2] Multiply volts by amperes; in each case we see that the energy is conserved although transformed. Third, here is a bottle of benzene whose molecular structure we assume to be in a definite form. [3]

The second aspect of mathematical thought used in science is the recognition of fundamental words which are taken without definition. Certain undefined terms are the foundation of geometry such as: point, straight line, equal distance, etc.; and in like manner we find words in science that must be taken as fundamental because they can not be defined except in terms of themselves or in terms of words that are more complex than themselves. I find these in science: mass, distance, time, force, element, cell.

To illustrate these I should like to show you a pair of balances [4], a meter stick [5], a stop watch [6], some spring balances [7], some sulphur and mercury [8], and a culture of one cell animals, amoebae [9]. These illustrate mass, distance, time, force, element, and cell.

The third aspect of mathematical thought helpful to scientists is the concept of proving theoretical laws from previous assumptions in much the same way that geometric theorems are proved from postulates. An important and common example of this is the law of inverse squares which says that any field of force from a point-source decreases as the square of the distance. This is seen in light as measured with a light meter [10]. It is also apparent in sound from bells [11]; and in the gravitation of the earth.

The fourth, and final aspect of mathematical method which is useful to scientists is the derivations of laws from the definitions of the words involved. Ohm's Law is a good example of this. After careful definition of the unit of resistance, the ohm, and the unit of current, the ampere, then the unit of electromotive force, the volt is defined as the force which will push one ampere of current through one ohm of resistance.[1] From this definition it follows automatically that the force is always equal to the amperes times the ohms. This shows how careful a scientist must be to define his units in a way that will help him the most in further work with them. Some of the credit for this care in defining original units can be taken by the mathematical background of science. [12].

So we have seen that the methods of mathematics contribute

[1] Many physicists will object to this discussion but we leave it as originally presented.—Ed.

four aids to scientific thinking: the need for unproved assumptions which are based upon experience; the recognition and adoption of fundamental, undefined words; the proofs of some laws from previous assumptions; and the automatic character of other laws from the definitions of the terms involved. The other big contribution of mathematics is the making of tools for scientists; these are perhaps four in number: the formula, geometry, concept of function, and continuity of the number system.

The formula is used by science for two purposes: to sum up a great many facts, and to predict future facts. As an example of a formula used to sum up facts I should like to have you watch these pendulums as we set them in motion. [13] Although it is clear that the shorter pendulums go faster, the exact relationship between the period of vibration and length is shown by a simple mathematical formula [14] where t is the time for the pendulum to swing and L is its length. There is also a formula which can be used to sum up the distance of twigs along branches [15] which is a little more complicated.

One of the most astonishing formulas used for prediction is that one derived by Dr. Carrel to determine whether a wound is healing at the correct rate. He measures the area of the open wound twice, six days apart, substitutes the values in a formula and can tell whether to probe in the wound for foreign matter or whether the wound is healing according to schedule.

Geometry is used in many ways. Parallelograms appear in force problems [16]. Parabolas are the shapes of trajectories [17] and headlight reflectors [18]. Heavy chains hang in Catenaries [19]. Soap bubbles take the shapes of spheres [20], showing that the least area for a given volume is a sphere. Gunpowder is granulated instead of solid because this increases the surface without changing the weight, thus allowing it to burn faster [21].

The concept of function is important and profound. Biologists have developed genetical functions which enable us to predict what we should expect from heredity. Weber and Fechner have found functions showing how much you would jump from a given electrical shock, how bright a light must be before you say it is twice as bright, and Haldane, an English biologist, has found a connection between the length of an animal and how far he can safely fall. This last allows us to predict how far it is safe to drop an elephant.

The system of numbers mathematicians have evolved

serves as a universal scale of reference. From the geologist who uses it to measure hardness of rocks to the psychologist who measures intelligence with his I.Q.'s, they all recognize it as the most useful reference. The same scale of numbers has been adapted to statistical studies of molecular physics which now seems to be an everlasting part of that science.

Mathematics finds much of its inspiration in science, and then in return contributes to science its methods and tools which are absolutely indispensable.

DEMONSTRATION EQUIPMENT NEEDED

1. Bottle of ammonia.
2. Transformer with two ammeters and two voltmeters.
3. Bottle of benzene.
4. Analytical balances.
5. Meter stick.
6. Stop watch.
7. Spring balances.
8. Sulphur and mercury.
9. Amoebae.
10. Bulb and light meter.
11. Three bells with batteries.
12. Light with ammeter, voltmeter.
13. Four pendulums.
14. Blackboard with chalk.
15. Branch of a tree.
16. Parallelogram of forces with spring balances.
17. Tennis ball.
18. Headlight reflector.
19. Heavy chain.
20. Soap bubble apparatus.
21. Gunpowder and matches.

BEHIND THE PHYSICS PROBLEM

JOSEPH A. MCGEE
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The mathematics problem has a unique place in the teaching of high school physics. It has a vital role to play in bringing about an awareness of the quantitative elements of the pupil's total environment. It is of major importance in the process of living intelligently to be conscious of such things as, for instance, the actual difference in effect of putting ice in a liquid to cool it, and putting ice water in a liquid to cool it; how much torque a certain wrench is applying on a bolt; how the deceleration of a car as affected by velocity and surfaces of the road and

tires; or how many lumens of light one is obtaining when one is reading by lamp light.

To play this part most effectively the problem should be carefully selected or carefully constructed by the teacher. It should be built around the materials that are available for manipulation. The data for the problem should be obtained right before the pupil's eyes. If something is weighed and measured then the calculations have an added reality. That which is weighed and measured can often be brought in from the home of a pupil. The teacher should realize that to the pupil there is something abstract about even the commonplace things when these things are a part in the school equipment. Quantitative thinking out of the class room may be engendered due to having brought in and studied an electric toaster, some ice, or a lens. These materials may constitute identical elements which connect out-of-school situations with the mathematical problem solving in school.

Everyone is aware of the necessity for a consumer value to physics. But does everyone agree on the meaning of consumer value? A teacher should not forget that it is not a mature person with whom he is dealing. The pupil as a consumer should not be treated as an adult consumer. The problem should be functional for the pupil. The problem may deal with the airplane, the baseball, the camera or with other items about which physics problems usually deal but should be worded in terms of the pupil's interests.

The problem should not be treated as simply a mathematical calculation. In gathering the data and in discussing the problem in class the physics problem should be correlated with as many phases of the pupil's life as possible. Mention should be made at every opportunity of the various situations where a similarity between the problem at hand and out-of-school situation exists. The pupil will contribute much in bringing out these similarities.

Finally the problem should bring about a better understanding of mathematical concepts. A problem in physics which illustrates inverse or direct proportion or other mathematical concepts should be used to emphasize the general manner in which the concept is found in the pupil's environment. When an inverse ratio is used the pupil should be encouraged to enumerate other phenomena where an inverse relationship exists, in the home, on the athletic field and in various other life situations.

The teacher who emphasizes correct answers only, and neglects the importance of understanding the method is not teaching how to reason. Some pupils arrive at the correct answer without a clear understanding, of why they did what they did to get the answer. The answer to a hypothetical problem, a problem dictated in the class room, has no intrinsic value. A correct answer as a conclusion to the hypothetical problem does have value to the one who thought out the process and worked out the problem, but only because it is the concluding phase of a complete process of thought. The greatest value is a correct answer plus a clear understanding of the method used to solve the problem when it is built around familiar objects and when the problem is associated in the mind of the pupil with experiences in his own life. Some teachers take the easy way of marking and give all or nothing on the "final answer." The very term "final answer" implies that from hence on it is not to be used again. But the process is to be used again or else one can write "final answer" after each unit in physics as it is completed, meaning the subject is closed and not to be referred to again. Greater emphasis on method, a generous proportion of credit for method and less emphasis and less credit for a final answer is desirable.

To sum it all up it should be emphasized that the mathematical problem in physics has a unique place in correlating the quantitative work of physics with the pupil out-of-school activities. To do this most effectively the problem should be selected carefully, being built around familiar objects which are associated with the pupil's experiences and interests out-of-school. The physics problem can help to make mathematical relationships more functional but it should not be an abstract problem in mathematics. Finally there is a greater value to the pupil in understanding the meaning and processes of doing the problem than in simply getting a correct answer. Therefore, the same kind of credit should be allotted to correct method as is allotted to correct answers in giving the pupil school grades, and emphasis should focus on making the quantitative thinking done in solving problems functional in the pupil's out-of-school experiences. One problem well explored and correctly solved will do more to engender analytical thinking and constructive reasoning than will a dozen haphazard rapid calculations simply to find an answer to a dozen similar problems.

7TH GRADE MATHEMATICS YULETIDE GREETING

CATHERINE ANN BARKER
Allegany High School, Cumberland, Maryland

Directions:

1. First work out all the problems and put the answer on the same line in the first column. Example—$47\frac{1}{2} \div 2\frac{1}{2} = 19$, so 19 goes in the first column.
2. Next put in the second column the letter of the alphabet which is the same as the number of your answer. Example—The 19th letter of the alphabet is *S* so where you have 19 you put an *S* in the second column.
3. Next fill in the chart at the bottom of the page with the correct letter under the chart letter. Example—*S* goes under *W*.

Problem	Number Answer	Letter Answer	Chart Letter
$47\frac{1}{2} \div 2\frac{1}{2}$	19	S	W
$78.75 \div 8.75$	9	I	O
$4.61 + 5.25 + 2.34 + 6.8$	19	S	P
$10\frac{1}{2} + 5\frac{1}{4} + 2\frac{1}{4}$	18	R	G
$.25 \times 4$	1	A	V
$72 \div 4$	18	R	F
4.5×4	18	R	N
$2\frac{1}{2} \times 2$	5	E	D
$101.75 - 81.75$	20	T	Q
$22 \div 2\frac{3}{4}$	8	H	L
$6\frac{1}{4} \times 4$	25	Y	J
$6\frac{1}{2} \times 2$	13	M	U
$100 - 97$	3	C	K
$7 + 6$	13	M	B
$1 \div 1$	1	A	X
Period	—	.	Z

CHART

Chart Letter	X	B	D	G	F	J	K	L	N	O	P	Q	U	V	W	Z
Answer Letter	A	M	E	R	R	Y	C	H	R	I	S	T	M	A	S	·

This is for each of you.

MATHEMATICS IN WAR

ROBERT STORM
1721 Noe Street, San Francisco, California

The best educated army will win this war! This war has been called a battle of production, but if men are not taught how to use the complicated machines of the modern warfare to the best advantage, our assembly lines will do us no good whatever. Mathematics and physics are the two paramount sciences on which mechanized and air warfare is based.

Are we prepared? Let us see what some of our armed forces have done with mathematics.

When an army bomber, flying over the crowded Los Angeles area, developed motor trouble and the crew was forced to abandon it, its young pilot stayed with the plane until all of his comrades had jumped; then, allowing for wind drift, speed, torque, and angle of descent, this army bomber pilot set the controls of his falling craft so that it would crash in the only clear space he could find. Homes, factories, crowded streets, and oil wells, covered all but one small vacant area. The pilot bailed out; the plane crashed in the clearing. That feat took lightning calculation. The lives of many civilians and the safety of vital defense works depended on that flier's knowledge of mathematics, and he came through with flying colors.

Take a look at the record of MacArthur's artillery on Bataan. It takes some fancy figuring and knowledge of shell trajectory to blast an enemy position which can't even be seen.

Corregidor's anti-aircraft gunners didn't bring down high altitude Jap bombers by guess work.

U. S. bombers don't score hits on enemy naval units and troop transports from 30,000 feet by just dropping their load of bombs and giving a little prayer. They must know what they are doing.

Of course, mathematics isn't by any means restricted to the battle areas. Our factories turn out fine precision instruments and huge 16-inch naval rifles, and they must be accurate. U. S. factories can turn out machinery accurate to the one ten-thousandth of an inch, and do it in mass production! (In order to gain this degree of accuracy, foreign manufacturers must have the finishing done by hand.)

Construction in the service, too, takes muscle, courage, and education. The engineer corps must build bridges under fire, must make them strong enough to support heavy trucks, tanks, and do it with the least material and time possible. Thorough knowledge of mathematics enables our army engineers to calculate the stress and strain on joints, the width of areas to be spanned, etc. It is also the job of the engineers to destroy bridges, buildings, and anything of military value in case they are not able to hold their position, and they must carry out this operation quickly and with a minimum of waste.

Of course men, tanks, guns and ships are of no use unless they can get to the field of operations, and bombers do no damage unless they reach the target area. In this war the field of battle is thousands of miles from our shores here in the United States, yet our armies are trained here and our equipment is made here. They must be transported across the Pacific and Atlantic, and that not only takes ships and planes, but expert navigators. Navigators, experts in the field of mathematics, must guide bombers to their targets and get them safely home again.

SCIENCE QUESTIONS

December, 1942

CONDUCTED BY FRANKLIN T. JONES
10109 Wilbur Avenue, S.E., Cleveland, Ohio

Contributions are desired from teachers, pupils, classes and general readers. Send examination papers from any source whatsoever. It is natural that questions connected with the War Effort will be especially appreciated. Questions on any part of the field of science; questions having to do with the pedagogy of science; new applications of old ideas; present variations of, perhaps, ancient questions; anything that appeals to the reader, or might appeal to other readers—all are wanted. What interests you will, most likely, interest others also.

We will endeavor to obtain answers to all reasonable questions. It is always valuable to get questions whether they can be answered or not.

Contributors to SCIENCE QUESTIONS are accepted into the GQRA (Guild of Question Raisers and Answerers).

Classes and teachers are invited to join with others in this co-operative venture in science.

JOIN THE GQRA!!!

431 are already members

WARTIME GASES

Refer to the March, 1942, number of SCHOOL SCIENCE AND MATHEMATICS *for the answer (pp. 276–280).*

983. (1) Did you read the article by Louis R. Welch—An Address before The Eastern Association of Physics Teachers? *Subject*—WARTIME GASES.

(2) Should you fear or respect *poison gas?*

Read the article by Leonard Milliman in Collier's *for September 26, 1942 (pp. 24–25). Post page 24 on your Bulletin Board.*

IT CAN'T BE DONE

Some Things That Investigators Have Given Up

1. Circle-squaring.
2. Perpetual Motion.

and

The National Inventors Council advises direction of efforts away from—

3. The invention of a net or screen to protect ships against torpedoes. Out of 100,000 ideas submitted to them, several thousand had to do with such protection. During World War I, the Naval Consulting Board received 6,740 similar suggestions. (*Science News Letter, October 3, 1942.*)

BUMBLE BEE—50-50—HELICOPTER

984. *They say (sign in General Motors plant, quoted or paraphrased in* Reader's Digest, *October, 1942, p. 69) that the bumble-bee should be, theoretically, unable to fly;* BUT—THE BUMBLE BEE GOES AHEAD AND FLIES ANYWAY!!!

IN THE PAST—Henry Ford built a car with self-contained power plant at a price that put one, or more, in nearly half the families of the United States.

NOW—Igor Sikorsky has built an amphibian helicopter that "hovers like a hummingbird over the exact spot where it will land (*Life*, October 19, 1942, pages 45–48), also it can do what neither bumble bee nor hummingbird can do—can land and take off on water. It costs about the same as a medium priced car and makes 15 m.p.h. per gallon of gasoline.

IN THE FUTURE—The boys and girls of today will be performing as scientific miracles the

THINGS THAT CAN'T BE DONE

MONEY IN YOUR POCKET

985. *Suggested by advertisements of Storm Windows, stoking the furnace, watching your automobile speed, shifting tires from wheel to wheel, and so on.*

1. Storm sash for your windows—How do they save coal, or gas, or oil? Is your home winterproof? (See *Consumers' Guide*, Oct., 1942.)
2. Thermostat on your furnace unit—How does it save coal, gas, or oil?
3. Automobile speed—How does it save on gas and oil, and why?
4. Shifting tires—How does it equalize tire wear?
5. Avoiding accidents—Safety precautions prevent some accidents and unquestionably reduce the severity of many accidents. There is the big loss in property damage and the more serious losses from personal injury to self and others. Did you ever think that a hospital does not make money from taking care of you when sick or injured? On the contrary your sickness or injury throws a heavier load upon the Community Fund upon whose existence your hospital depends.
6. Watch those service charges—*Consumers' Guide* (October, 1942) warns the public to watch ceiling prices not only for goods but for services. (N.B. Don't *assume* you are being "gypped" on prices but keep your eyes open, and a safe way is not to go again to any place where you suspect that improper prices are charged.)
7. In general, conserve present equipment whatever it may be.
8. Watch for ways to conserve. Each saving puts

MONEY IN YOUR POCKET.

ANSWERS

981. *Ferdinand the Bull—*

Proposed by Patricia Porter (GQRA, No. 366), Madison, Wis. "Does a bull see red or does he see all the colors, red being the only one that irritates him?"

"What colors does a bull see, if any?"

Answer by request from Dr. Calvin S. Hall, Department Head, Psychological Laboratory, Western Reserve University, Cleveland, Ohio. (Elected to the GQRA, No. 432.)

"Regarding the effect of color on bulls, G. M. Stratton in *The Psychological Review* for 1923, Vol. 30, pp. 321–325, reported the following experiment.

"He made four banners, two by six feet each, of white, black, red and green cloth. They were attached lengthwise to a line of such a height that the cattle could easily move under them. Small herds of cattle were observed at one time. Stratton concludes:

"1. There was no strong excitement from the colors as a whole or from any one of them. There was interest, hesitation, mild distrust toward all and any of the banners, as toward strange things.

"2. None of the colors caused any reactions that could be recognized as anger.

"3. Brightness and movement, rather than hue, caused responses in the cattle. A slightly greater interest and mistrust was shown toward white than toward any other; toward a fluttering banner rather than toward a still one.

"4. There were no differences in the reactions of bulls, cows, steers, or calves."

"Stratton questioned sixty-four cattlemen and found that only eleven of them believed that red is particularly exciting to cattle.

"I hope this answers your question satisfactorily."—C.S.H.

Now is there someone who has been chased by a bull who can calmly view his predicament and give us a reason (we hope the true reason) why the bull chased him?—F.T.J.

961. *Proposed by C. S. Greenwood (GQRA, No. 135), Sheffield, Pa.*

"Does our present brand of daylight-saving time, War Time, actually save electricity, and to what degree?"

Discussion—

Quotation from report of the Cleveland Electric Illuminating Co. on output for May, 1942:

"War time, which moved all clocks one hour ahead of the eastern standard time that ordinarily prevails here, was regarded as a factor in a declaration in May of the rate of increased use of electric current for residences and small customers of the CEI.

"While the current consumption of the average commercial customer in April represented a gain of 8.8 kilowatt hours over the same month of 1941, the increase over May, 1941, was only 4.4 K.W.H.

"This was believed due in part to war time's lengthening of the period of daylight after normal working hours, to the city blackout ordinance requiring the extinguishing of electric signs that might be visible from the air, to earlier closing hours for gasoline atations, and to the fact that businesses which are open at night do not need as much current for illumination as they would if eastern standard time were in effect."

In other words WAR TIME SLOWS UP CURVE OF CURRENT CONSUMPTION for the C.E.I.

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966. *Window Breakage by Explosion.*

Proposed by Harry Delfs (GQRA, No. 426), Chicago Ill. "I would like to know why all the windows in the vicinity of an explosion always shatter outward and never inward."

Answer: From a newspaper clipping—

"Certain important effects of air raids, discovered by British scientists, were revealed in a special London communication today.

"Among the significant results of these studies, now of general interest for the civilian defense of this country are the following:

"Explosives like air bombs, act by liberating energy in extremely short periods of time. In a car, 10 gallons of gasoline may be used up in five hours. The same amount of high explosive in a 100-lb. bomb will liberate energy in 1/200,000th of a second.

"The mechanical effects of explosives are far more important than heat effects. Explosives produce a shock wave of extremely high intensity traveling through a body at a very high speed.

"The shock wave in the air is the blast wave, and is responsible for breaking of windows in an air raid. This wave is due not merely to an increase of pressure; behind the pressure wave there is a backward pull.

"When the explosive is feeble or far away, the window bends away from the explosion, then springs back again and breaks. If the explosion is near, the window breaks while moving away from it, and the glass is thrown inwards."

(Please compare this answer with the one given in the November, 1942, number of SCHOOL SCIENCE AND MATHEMATICS.)

KEEPING UP WITH SCIENCE AND INDUSTRY

Articles, books, references

33. "War Gases"—Address by Louis R. Welch before Eastern Associa-

tion of Physics Teachers (SCHOOL SCIENCE AND MATHEMATICS, March, 1942, pp. 276–280.).

34. "The Truth About Poison Gas"—By Leonard Milliman, *Collier's* for Sept. 26, 1942, pp. 24–25, Illustrated. Page 24 is good material for Bulletin Board.
35. "Vitamin Table"—*Consumers' Guide*, Feb. 15, 1941, page 4.

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950. *Requests to be put on General Motors and other Mailing Lists.*
13. Fr. Bernard Bailey, 810 Leland Ave., Chicago ,Ill.

WARTIME ACTIVITIES OF GQRA MEMBERS

What are you doing in connection with the war?

Teaching pre-flight aeronautics, or mathematics, or meteorology, or what?
Are you in active service?
Are you working in a defense plant?
Are you serving as an air raid warden, or a rationing officer?
Please send in word.

Philip B. Sharpe (GQRA, No. 262), formerly Greenwich, N. Y., is working in a shipyard in Maine.

GQRA members are asked to mail their pictures, formal or snapshot, to the Editor of the Department.

A "Contributors' Scrapbook" is contemplated. Please respond.

NEW MEMBERS OF THE GQRA

432. *Dr. Calvin S. Hall, Head of Department, The Psychological Laboratory, Western Reserve University.*

New Members in 1942—Fourteen

THE COOPERATIVE COMMITTEE ON SCIENCE TEACHING

Public Meeting
New York City, Tuesday, December 29, 1942
Hotel Pennsylvania
2:30 P.M.

HIGH-SCHOOL SCIENCE AND MATHEMATICS AND THE MANPOWER PROBLEM

Where Do We Stand?
Robert J. Havighurst, The University of Chicago.
What Can Biology Teachers Do to Meet Manpower Needs?
Oscar Riddle, Carnegie Institution of Washington.
What Can Mathematics Teachers Do to Meet Manpower Needs?
Raleigh Schorling, The University of Michigan.
What Can Physical Science Teachers Do to Meet Manpower Needs?
Karl Lark-Horovitz, Purdue University.

The Cooperative Committee on Science Teaching is Sponsored by:
American Association of Physics Teachers.
American Chemical Society.
The Mathematical Association of America.
National Association for Research in Science Teaching.
Union of American Biological Societies.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

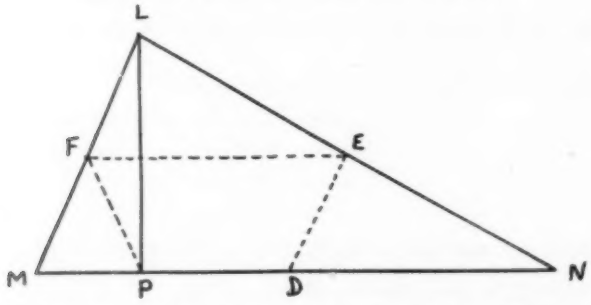
3. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

1777. *Proposed by Isabella Moore, Boston, Mass.*

In triangle LMN, D, E, and F are the midpoints of MN, NL and LM respectively. If LP is perpendicular to MN, show that D, P, E, F are concyclic. (P is on MN).

Solution by Alan Wayne, Flushing, N. Y.



Drawing FE, FP, and ED as in the figure, $FE \| PD$, $ED \| FM$, and $ED = FM$, since the line joining the midpoints of two sides of a triangle is parallel third side, equals half of it. But $PF = FM$ since median to hypotenuse is half of hypotenuse. Hence $ED = PF$ and $PFED$ is an isosceles trapezoid and is inscriptible in circle (or its opposite angles may readily be shown to be supplementary, hence it is cyclic).

Note: the circle $PFED$ is the 9 point circle.

Solutions were offered also by Clarene S. Warne, Romulus, N. Y.; M. Kirk, West Chester, Pa.; Nellie Waugh, Madison, Wis.; Betty Burnside, Winnipeg, Canada; Walter R. Warne, Rochester, N. Y.; Myrtie Hyatt, Suffern, N. Y.; Francis Moore, Washington, D. C. and Aaron Buchman, Buffalo, N. Y.

1778. No solution has been offered.

1779. *Proposed by Parker Brown, Benton Harbor, Mich.*

What fractions with denominators of 7 and 11 are divisible by $2\frac{30}{77}$?

Solution by Malcolm Kirk, West Chester, Pa.

Suppose the integer x to be the numerator of the desired fractions. Then,

$$\frac{x}{7}\div\frac{184}{77}\equiv\text{an integer}=\frac{11x}{184}$$

and

$$\frac{x}{11}\div\frac{184}{77}\equiv\text{an integer}=\frac{7x}{184}$$

Since 7 and 11 are prime and are not contained in 184, x is an integral multiple of 184.

$$\therefore\quad \text{the fractions are } \frac{184n}{7} \text{ and } \frac{184n}{11}$$

where n is any positive or negative number.

Solutions were offered also by W. R. Smith, Suttons Bay, Mich.; Alan Wayne, Flushing, N. Y. and Walter R. Warne, Rochester, N. Y.

1780. *Proposed by Constance Kunes, Dundee, Mich.*

Resolve into factors $(a+b+c)(a+b-c)(a+c-b)(b+c-a)(a^2+b^2+c^2)$.

Solution by Malcolm Kirk, West Chester, Pa.

Multiplying the given factors and arranging terms, the indicated product equals:—

$$\begin{aligned}(a^2b^4-2a^2b^2c^2+a^2c^4)+(b^2c^4+c^2b^4-b^6-c^6)+(b^2a^4+c^2a^4-a^6)&\\ =(b^2-c^2)^2a^2-(b^2-c^2)^2(b^2+c^2)-a^4(a^2-b^2-c^2)&\\ =(b^2-c^2)^2(a^2-b^2-c^2)-a^4(a^2-b^2-c^2)&\\ =[(b^2-c^2)^2-a^4](a^2-b^2-c^2)&\\ =(b^2-c^2+a^2)(b^2-c^2-a^2)(a^2-b^2-c^2)&\end{aligned}$$

A solution was also offered by Walter R. Warne, Rochester, N. Y.

1781. *Proposed by Jane Mooney, Dundee, Mich.*

Solve:

$$\sqrt{1+x^2}-\sqrt{1-x^2}=\sqrt{1-x^4}.$$

Solution by (name omitted for this problem and also 1777.)

Method I.

Squaring both sides and collecting terms.

$$2-2\sqrt{1-x^4}=1-x^4.$$

Let

$$1-x^4=m^2, \quad \text{then} \quad m^2+2m-2=0.$$

Hence,

$$m=\frac{-2\pm\sqrt{12}}{2}=-1\pm\sqrt{3} \quad \text{and,} \quad \sqrt{1-x^4}=-1\pm\sqrt{3}$$

Squaring,

$$1-x^4=4\pm2\sqrt{3}$$

$$x=\pm\sqrt[4]{-3\pm2\sqrt{3}}.$$

Two of these values are complex.

Method II.

Let

$$(1+x^2)=u^2$$

and

$$1-x^2=v^2$$

Then,

$$1-x^4=u^2v^2$$

Thus from the original equation,

$$\sqrt{1+x^2}-\sqrt{1-x^2}=\sqrt{1-x^4}$$

we have

(1) $$u-v=uv$$

also

(2) $$u^2+v^2=2$$

Square (1) on both sides

$$u^2+v^2-2uv=u^2v^2$$

But

$$u^2+v^2=2,$$

hence

$$2-2uv=u^2v^2.$$

Let

$$uv=m$$

$$2-2m=m^2$$

which is the same equation as before.

A solution was also offered by Malcolm Kirk, West Chester, Pa.

1782. *Proposed by Howard D. Grossman, New York, N. Y.*

Let

$$S_1=1+\tfrac{1}{3}+\tfrac{1}{5}+\tfrac{1}{7}+\cdots,$$

And

$$S_2 = -\tfrac{1}{2} - \tfrac{1}{4} - \tfrac{1}{6} - \tfrac{1}{8} - \cdots,$$

Also S_3 = the series formed by taking in order u terms from S_1, v terms from S_2, then the next u from S_1, etc. Show that S_3 converges to the limit, $\log 2\sqrt{u/v}$.

Solution by the proposer

The difference between the first column and the second approaches 0 as n approaches ∞.

$1+\frac{1}{2}+\frac{1}{3}+\cdots+\frac{1}{n}$	$\log n+C$ (the Eulerian constant)
$\frac{1}{2}+\frac{1}{4}+\frac{1}{6}+\cdots+\frac{1}{2n}$	$\frac{1}{2}\log n+\frac{C}{2}$
$1+\frac{1}{3}+\frac{1}{5}+\cdots+\frac{1}{2n-1}$	$\log 2n-\frac{1}{2}\log n+\frac{C}{2}$
$\left(1+\frac{1}{3}+\frac{1}{5}+\cdots+\frac{1}{2r-1}\right)$ $-\left(\frac{1}{2}+\frac{1}{4}+\frac{1}{6}+\cdots+\frac{1}{2s}\right)$ $+\left(\frac{1}{2r+1}+\frac{1}{2r+3}+\cdots+\frac{1}{4r-1}\right)$ $-\left(\frac{1}{2s+2}+\frac{1}{2s+4}+\cdots+\frac{1}{4s}\right)$ $\cdots\cdots\cdots\cdots\cdots$ $+\left(\cdots+\frac{1}{2nr-1}\right)-\left(\cdots+\frac{1}{2ns}\right)$	$\log 2nr-\frac{1}{2}\log nr-\frac{1}{2}\log ns$ $=\log 2\sqrt{r/s}$

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

For this issue the Honor Roll appears below:

EDITOR'S NOTE TO HIGH SCHOOL STUDENTS:—It is the hope of the Editor that this year will bring more contributors to this department. Please send problems, solutions, comments.

1777. K. A. G. Miller and David Pilkington, both from Upper Canada College, Toronto.

1779. David Pilkington, Upper Canada College, Toronto.

PROBLEMS FOR SOLUTION

1795. *Proposed by Myrtle Hyatt, Newburg, N. Y.*

The sum of two numbers is 5432 and their lowest common multiple is 223020. Find the numbers.

1796. *Proposed by Clinton Burroughs, East Varick, N. Y.*

Prove that a triangle ABC is equilateral if

$$\cot A+\cot B+\cot C=\sqrt{3}$$

1797. *Proposed by J. M. Maxey and Paul C. Overstreet, Wilmore, Ky.*

Given

$$a^2-b^2=c^2-d^2=e^2-f^2$$

and

$$a+b+c+d+e+f=3119$$

Find positive, integral values of all letters involved which will satisfy the two equations.

1798. *Proposed by Paul D. Thomas, Durant, Okla.*

The quadrilateral $ABCD$ is inscribed in a circle, with D as a variable vertex on the circle. If A', B', C' and D' are mid-points of semicircles described externally on sides AB, BC, CD and DA respectively, find the locus of intersection of $A'C'$ and $B'D'$.

1799. *Proposed by George W. Conn, Elm Beach, N. Y.*

When each of two sides of a right triangle is subtracted from the hypotenuse there results 8 and 4. Find the three sides. A plane geometry or trigonometric solution is desired.

1800. *Proposed by Nathan Yoder, Petersburg, Va.*

Show that the roots of $ax^2+2bx+c=0$ are complex if a, b and c are in harmonic progression.

BOOKS AND PAMPHLETS RECEIVED

SIMPLIFIED INDUSTRIAL MATHEMATICS, by John H. Wolfe, Ph.D., *Supervisor of Ford Apprentice Training, Ford Motor Company, Dearborn, Michigan;* William F. Mueller, A.B., *Principal of Ford Aircraft Apprentice School, Ford Motor Company, Dearborn, Michigan;* and Seibert D. Mullikin, B.S., *Principal of Ford Airplane Apprentice School, Ford Motor Company, Willow Run, Michigan.* Cloth. Pages xiii+281. 12×20 cm. 1942. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $2.00.

BASIC MATHEMATICS: A SURVEY COURSE, by Walter W. Hart, *Author of Mathematics Texts.* Cloth. Pages vi+456. 13×20 cm. 1942. D. C. Heath and Company, 285 Columbus Avenue, Boston, Mass. Price $1.52.

OUTLINES OF ECONOMIC ZOOLOGY, by Albert M. Reese, *Professor of Zoology, West Virginia University, Morgantown, W. Va.* Fourth Edition. Cloth. Pages xii+359. 14.5×21.5 cm. 1942. The Blakiston Company 1012 Walnut Street, Philadelphia, Pa. Price $3.25.

MEDICAL PARASITOLOGY, by James T. Culbertson, *Assistant Professor of Bacteriology, College of Physicians and Surgeons, Columbia University.* Cloth. Pages xvi+285. 15×23 cm. 1942. Columbia University Press, Morningside Heights, New York, N. Y. Price $4.25.

PRACTICAL MATHEMATICS FOR HOME STUDY, by Claude Irwin Palmer, *Late Professor of Mathematics and Dean of Students, Armour Institute of Technology,* and Samuel Fletcher Bibb, *Associate Professor of Mathematics, Illinois Institute of Technology, Armour College of Engineering.* Third Edition. Cloth. Pages xxix+697. 12.5×19 cm. 1942. The McGraw-Hill Book Company, 330 W. 42nd Street, New York, N. Y. Price $4.00.

GEOMORPHOLOGY, by O. D. von Engeln, *Professor of Geology in Cornell University.* Cloth. Pages xxii+655. 15.5×23.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $4.50.

A STUDY OF THE APPLICATION OF AN EDUCATIONAL THEORY TO SCIENCE INSTRUCTION, by Eugene A. Waters, Ph.D. Teachers College, Columbia University Contribution to Education, No. 864. Cloth. q34 pages. 15×23 cm. 1942. Bureau of Publications, Teachers College, Columbia University, New York, N. Y. Price $1.60.

THE ELECTRICAL FUNDAMENTALS OF COMMUNICATION, by Arthur Lemuel Albert, M.S., E.E., *Professor of Communication Engineering, Oregon State College; Professor of Electrical Engineering, Purdue University (1942–1943).* Cloth. Pages vii+554. 14.5×23 cm. 1942. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $3.50.

PRINCIPLES OF FLIGHT, by Bert A. Shields, *Lt. Comdr., U.S.N.R., Chief Instructor in Charge of Civilian Pilot Training, Polytechnic Institute of Brooklyn.* Cloth. Pages vii+363. 14×20.5 cm. 1942. McGraw-Hill Book Company, 330 West 42nd Street, New York, N. Y. Price $1.88.

FIRE PREVENTION EDUCATION, prepared by the Center for Safety Education, New York University, and the Committee for Fire-Prevention Education representing Eleven National Educational and Fire-Safety Agencies and Organizations. Cloth. Pages xvi+355+v. 14×21 cm. 1942. The National Board of Fire Underwriters, 85 John Street, New York, N. Y. Price 85 cents.

THE ORIGIN OF THE CAROLINA BAYS, by Douglas Johnson, *Professor of Geology in Columbia University.* Cloth. Pages xi+341. 16×23.5 cm. 1942. Columbia University Press, Morningside Heights, New York, N. Y. Price $4.50.

PRINCIPLES OF AIRCRAFT ENGINES, by Bert A. Shields, *Lt. Cmdr., U.S.N.R., Chief Instructor in Charge of Civilian Pilot Training, Polytechnic Institute of Brooklyn.* Cloth. Pages ix+378. 14×20.5 cm. 1942. McGraw-Hill Book Company, 330 West 42nd Street, New York, N. Y. Price $1.88.

MAP READING AND AVIGATION, by Richard M. Field, *Princeton University,* and Harlan T. Stetson, *Masssachusetts Institute of Technology.* Cloth. Pages xiii+129. 21.5×28 cm. 1942. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y. Price $2.50.

LABORATORY GEOMETRY, by Elizabeth Roudebush, M.A., *Teacher of Mathematics, Roosevelt High School, Seattle, Washington.* Paper. Pages v+192. 20×27.5 cm. 1942. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y. Price $1.12.

ELEMENTARY METALLURGY, by W. T. Frier, B.S., *Foundry Control Chemist, General Electric Company, Erie Works; Instructor in Metallurgy, General Electric Technical Night School, Erie Works.* Cloth. Pages ix+207. 15×20.5 cm. 1942. McGraw-Hill Book Company, 330 West 42nd Street, New York, N. Y. Price $1.75.

PRE-FLIGHT AERONAUTICS, Prepared by High School Teachers' Aeronautics Class. Summer Session, 1942. Paper. Pages vi+31. 20.5×27.5 cm. The State College of Washington, Pullman, Wash. Price 40 cents.

A REVIEW OF ARITHMETIC, Prepared by Zens L. Smith, *Assistant Professor of Mathematics, The University of Chicago.* Paper. 37 pages. 20.5×27.5 cm. 1942. The Institute of Military Studies, The University of Chicago, Chicago, Ill. Price 25 cents.

YOUR WINGS. Paper. 32 pages. 21.5×28 cm. United Air Lines, Municipal Airport, Chicago, Ill.

LET'S INVESTIGATE, AN EXPERIMENTAL APPROACH TO CONSUMER SCIENCE, by Alfred H. Hausrath, Jr., *Iowa State College*, and John H. Harms, *Ames High School, Ames, Iowa.* Paper. Pages iv+154. 20×28 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price 80 cents.

MANUAL OF WAR-TIME HYGIENE, by Dean Franklin Smiley, A.B., M.D., *Professor of Hygiene and Preventive Medicine in Cornell University, Lieutenant-Commander, United States Naval Reserve;* and Adrian Gordon Gould, Ph.B., M.D., *Attending Physician and Assistant Professor of Hygiene and Preventive Medicine in Cornell University, Lieutenant-Colonel, Medical Corps, United States Army.* Paper. Pages iii+86. 14×21.5 cm. 1942. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $1.00.

BOOK REVIEWS

THE DEVELOPMENT OF INFORMAL GEOMETRY, by Robert Coleman, Jr., Ph.D., Teachers College, Columbia University Contributions to Education, No. 865. Cloth. Pages xii+178. 14.5×23 cm. 1942. Bureau of Publications, Teachers College, Columbia University, New York, N. Y. Price $2.10.

This is a doctoral dissertation which traces the development of informal geometry in Germany, England, and the United States, starting with the work of Pestalozzi. Approximately half of the material is devoted to informal geometry in Germany. In the United States an attempt is made to analyze the effect of groups holding varying points of view upon present day practices. In the opinion of the author, informal geometry is likely to become of increasing importance. For those interested in a detailed historical treatment, this book will be of considerable value. As might be expected, a rather extensive bibliography is given.

CECIL B. READ
University of Wichita

A TREATISE ON PROJECTIVE DIFFERENTIAL GEOMETRY, by Ernest Preston Lane, *Professor of Mathematics, The University of Chicago.* Cloth. Pages ix+466. 18×24.5 cm. 1942. The University of Chicago Press, Chicago, Ill. Price $6.00.

This book is a sequel to the author's 1932 book on projective differential

geometry, presenting new developments in the field. Quite definitely this is not an elementary textbook, but a treatise covering in considerable detail the theory to date; included are several previously unpublished results of the author. In many places one finds statements of additional theorems, the formal proofs being omitted because of lack of space, but with reference to the proper source, as listed in the rather complete bibliography.

A somewhat unusual feature is found in the introductory paragraph of each chapter. The author clearly and concisely states exactly what is to be the content of the chapter, then proceeds to develop the subject matter. In fact, to a very large extent, the same plan is followed in each section of a chapter. As a result the reader is not left wondering just where the discussion will lead, and the material becomes much more understandable. It is unfortunate that more authors have not adopted such an excellent style. The printing seems exceptionally well done.

Without doubt this book will have to be considered an essential reference work for all university and many college libraries.

CECIL B. READ

THE SUBJECT FIELDS IN GENERAL EDUCATION, Written in Collaboration by John J. DeBoer, *Director of Student Teaching, Chicago Teachers College*. Cloth. Pages ix+239. 14×21.5 cm. 1941. D. Appleton-Century Company, Inc., New York, N. Y. Price $1.50.

This volume presents a comprehensive report on the place of the secondary school subject fields in general education. The book is a compilation of material submitted by committees in the following fields of secondary education: Social Studies, English, Journalism, Speech, Modern Foreign Languages, Natural Science, Mathematics, Home Economics, Health and Physical Education, Business Education, and Art. One chapter is devoted to a clarification of the services rendered by the high school library. The final chapter represents a plea for more cooperation in the subject fields and curriculum planning in general.

It is evident that there is considerable merit in a volume of this type to clarify the present scope and emphasis in the subject fields discussed therein. To both the professional and non-professional reader it gives a comprehensive understanding of what the American Secondary School is attempting to do in the individual subject areas. To high school teachers the book serves as a source of enlightenment on the contributions made by the secondary school to general education.

W. A. EGGERT
De Paul University

THE PLACE OF MATHEMATICS IN SECONDARY EDUCATION, The Final Report of the Joint Commission of The Mathematical Association of America and The National Council of Teachers of Mathematics. Cloth. xvii+254. 2×16×24 cm. 1940. Bureau of Publications, Teachers College, Columbia University, New York.

As a background for discussing the place of mathematics in any system of education, it seems appropriate that some attention be given to the ways in which this subject has assisted in the development of our divilization and the extent to which *we now depend upon it*. Teachers of mathematics would profit much from reading and studying the "Joint Commission Report" to aid them in their own thinking for the present and the future.

JOSEPH J. URBANCEK
Chicago Teachers College

THE MATHEMATICS OF BUSINESS, A STUDY OF MATHEMATICS FOR PERSONAL, CIVIC AND BUSINESS EFFICIENCY, by Hugh E. Stelson, *Kent State University*. Cloth. xiv+370+94. 3×14×21 cm. 1940. Houghton Mifflin Company, Chicago. Price $2.50.

The materials of this book were prepared, during several years of experimentation, for the following groups of college students: liberal arts, home economics, school of education, and commerce-secretarial.

In addition to the topics of social importance the author has provided full training in the mathematics of business operations. The first chapter reviews the fundamental processes of mathematics for those who need such review. Chapters on roots, powers, interpolation, and logarithms provide drill in computation. The chapter on statistics gives the treatment of the proper graphical handling of numerical facts, and the chapter on annuities provides for those who need a more thorough mastery of the technical aspects of finance.

JOSEPH J. URBANCEK

PRINCIPLES OF MECHANICS, by J. L. Synge, M.A., Sc.D., *Professor of Applied Mathematics, University of Toronto*, and B. A. Griffith, M.A., Ph.D., *Lecturer of Applied Mathematics, University of Toronto*. Cloth. 3×16×24 cm. 1942. McGraw-Hill Book Co., Inc., New York, Price $4.50.

The book is divided into two parts—Part I, Plane Mechanics, and Part II, Mechanics in Space. Part I is complete in itself and might be used as a textbook in plane statics and dynamics, with ventures into three-dimensional theory. Vector notation is used sparingly. Calculus, analytical geometry, and elementary differential equations background needed and a knowledge of physics is very desirable. In Part II vectors are used extensively and solid analytical geometry is required. This part is complete in itself except for references to Part I. Except for the section on electron optics the selection of particular applications follows conventional lines.

JOSEPH J. URBANCEK

THE TRISECTION PROBLEM, by Robert C. Yates, *Associate Professor of Mathematics, Louisiana State University*. Paper. 68 pages, 15×23 cm. 1942. The Franklin Press, Inc., Baton Rouge, La.

No, this is not another attempt, but rather a neat package of information concerning the old, yet perennially new, problem of trisecting an arbitrary angle. This monograph should be of interest to all mathematics teachers, teachers in training, and also furnish interesting material for high school students. Although much of the algebraic and graphic treatment appears to be too difficult for the high school student, most of the constructions and devices are clearly presented and may be performed without great difficulty.

The five chapters present a clear historical and logical development of the problem and its solutions. The first chapter formulates the problem in terms of algebraic and trigonometric equations and discusses various angles which may or may not be trisected by means of Euclidean tools alone. The second chapter shows the use of special curves familiar to mathematics and related fields in effecting a solution. The third chapter presents fifteen mechanical trisectors ranging from the marked straight edge to more complicated linkages. Of these, the use of the carpenter's square and the draughting triangles should prove of interest. Chapter IV develops a number of Euclidean constructions which yield approximate solutions and compares these methods in terms of their errors. The final chapter entitled

"Don Quixotes," cleverly discusses publicized "solutions" in the form of case studies. In most of these the error is pointed out, or the general fallacy exposed.

This monograph performs a yeoman service in collecting such widely scattered material, and should prove to be one of the more popular items in the school library. From the viewpoint of the mathematics teacher, it is a must.

W. K. McNabb
La Grange, Ill.

LIVING CHEMISTRY, by Maurice R. Ahrens, Norris F. Bush, and Ray K. Easley. Cloth. Pages xviii+528. 21×25.5 cm. 1942. Ginn and Company Boston. Price $2.28.

The material presented in *Living Chemistry* grew out of twelve years of experimentation by the authors in cooperation with their pupils. The purpose of the reorganization is to make the study of chemistry a living experience. This is achieved through the solution of problems selected by, and of real interest to, high school pupils.

The book is divided into four parts. Part I—Fundamentals of Chemistry—contains ten units of material on: social and individual implications of chemistry, energy, matter and its structure, oxygen, hydrogen, formulas, equations, solutions and ionization, acids, bases, salts, and oxides. With the background obtained in this section the pupil is prepared to attack the problems in the remainder of the book. Nine units in part II, Chemistry of the Individual, discuss the function of water in the body, food and nutrition, glands, disease, drugs, cosmetics, clothing, hobbies, and vocations. In part III the pupil studies nine units on the Chemistry of the Home: food and its cooking and preservation, kitchen and table equipment, fuels, refrigeration, sanitation, materials of home construction and decoration, and gardening. Part IV, Chemistry of the Community, devotes five units to problems of water supply, sewage disposal, food production and distribution, industrial chemistry, and warfare.

Each unit begins with a brief introduction, a list of purposes to be achieved, and problems to be solved. The vocabulary is understandable by senior-high-school pupils. The two column page is used throughout. At the end of the discussion of each problem are questions to be answered. An objective practice test and references for further reading close the unit. Problems for individual study are included at the end of units after part I.

Numerous photographs, charts, diagrams, and drawings illustrate the text. Many of the photographs show pupils demonstrating to illustrate the principles of chemistry. Tables are ample in number and content. The appendix is very brief, and contains chiefly information about the Gas Laws and the Periodic Table.

The authors claim that their pupils have learned the facts and concepts of chemistry and have succeeded in college chemistry courses just as well as those who have followed the traditional organization in chemistry. In addition, it is claimed that evidence shows that concepts in chemistry are better retained and applied, and that the pupil growth in the modern objectives of science teaching is greater through study of meaningful problems rather than from a study of organized facts and principles. This textbook will be welcomed by those teachers who are seeking a text that follows the recommendations of "Science in General Education."

Marion C. Hays
Lake Forest Academy
Lake Forest, Illinois

Two important books for

PRE-INDUCTION TRAINING . . .

Especially suitable for the Pre-Induction Training Courses in the last two years of high school, recommended by the War Department and the U. S. Office of Education, covering *Fundamentals of Machines* and *Fundamentals of Electricity*.

Smith's MECHANICS

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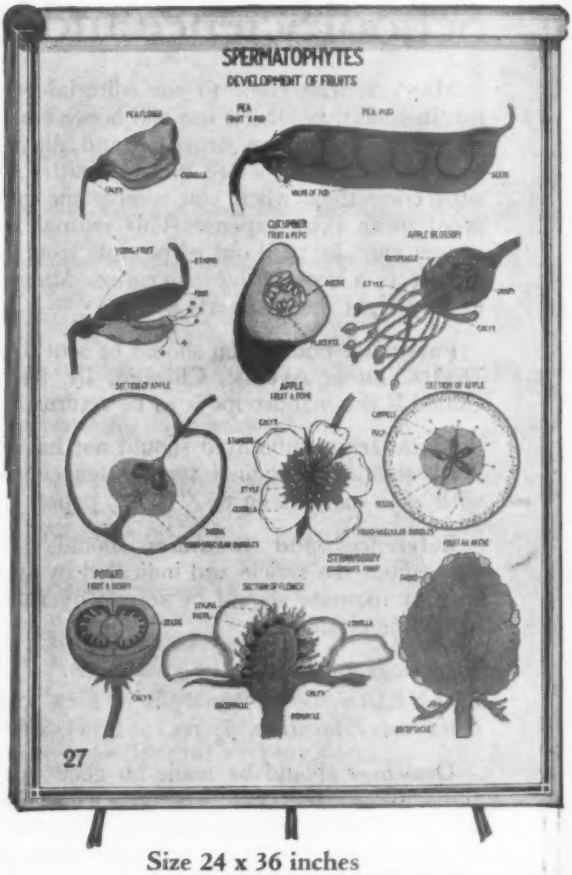

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MAHOGANY TREES FROM AFRICA GIVE PROMISE AS HARDWOOD CROP IN FLORIDA

Mahogany for future fleets of speed boats, as well as for home and hotel furniture, may come from cultivated forests of African trees grown in Florida. Experimental plantings of Rhodesian mahogany trees on the grounds of the subtropical experiment station of the University of Florida, near here, are catching up in height with native fast-growing pines twice their age, have trunks twice the diameter of pines as old as themselves, and appear to be forming wood four or five times as fast.

On the strength of this performance, S. J. Lynch and H. S. Wolfe of the experiment station staff express the opinion that they "appear to be the most promising hardwoods for reforestation in South Florida that have been tested by the Sub-Tropical Experiment Station."

The trees belong to one of two African genera of mahoganies, and are known botanically as Khaya nyasica. To distinguish them from other African mahogany species, it is proposed to call this species East African or Rhodesian mahogany. The African mahoganies generally are closely related to the American genus, Swietenia.

The oldest trees in the plantings here, although set out in rather unpromising-looking sites only 12 years ago, already have seven- to eight-inch trunks and average around 40 feet in height. Although distinctly tropical in origin, they have survived several cold spells, including one freeze when the temperature dropped to 27 degrees Fahrenheit. So far, the trees have not been attacked by insect pests or diseases; but the botanists here are chary about claiming immunity for them on that score.

FIELDS OF RED AND VIOLET SNOW DUE TO MICROSCOPIC FORMS OF LIFE

Fields of red and purple snow in the Northland are due to microscopic plants. These single-celled algae, one of the most primitive groups of living things, were investigated by Erzsébet Kol, Hungarian woman scientist working under a Smithsonian fellowship.

Her report of the vivid "blooms" in Alaskan mountain ranges has just been published here by the Smithsonian Institution. In this forbidding arctic environment, she found nearly 50 examples of the tiny plants living in almost infinite numbers on perpetual ice and snow. Collecting living specimens, Miss Koll headed for her laboratory high in the Swiss Alps where she planned to cultivate and study this strange form of life. War now has severed communication with Miss Kol. Except for news of the loss of her living specimens, no word has been received here on how the war has affected the project.

Her previous reports indicated that some of these algae are very fussy about their home surroundings. One wouldn't live on ice. Another wouldn't live on snow. And there are striking changes in algae types depending on whether surrounding mountain slopes are acid or alkaline in composition. This is probably due to their reliance on air-borne particles of decomposing and shattered rock for food. Dust dissolves slowly in the moisture on snow or ice surfaces, providing the minerals essential for life. The snow and ice plants perhaps serve as the chief food for some other form of life, it is believed, which in turn supports higher forms. The life cycle of the vividly colored organisms remains unknown, however.

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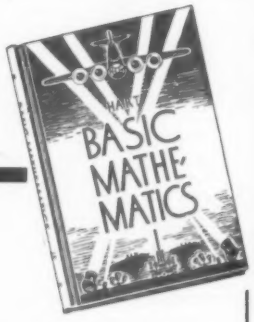

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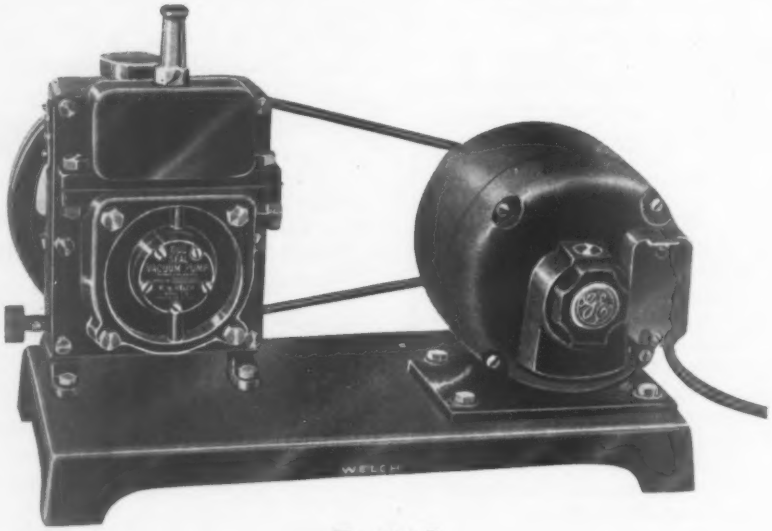

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